CHEMICAL & METALLURGICAL ENGINEERING

McGraw-Hill Co., Inc. April 12, 1922 25 Cents Per Copy

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
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Volume 26 | New York, April 12, 1922 | Number 15

Bad Paint and Good Medicine

THERE was a graduate of the University of Pennsylvania who was engaged in a zinc oxide works where, of a sudden, they had trouble. There was something wrong, something unusual in the product. So the Pennsy man dissolved the product, precipitated the zinc, filtered and then added hydrogen sulphide to the filtrate. This showed a white precipitate. In the back of his head was the recollection that germanium sulphide was white, and he announced his observation of the presence of this rare element. Older heads urged him to calm himself, and assured him that his remarkable find was nothing but sulphur. But he dissolved his so-called "sulphur" in aqua regia and H_2S brought it down again. Other tests confirmed his analysis.

Faithful to his *alma mater,* he sent a sample to the Philadelphia laboratory, whereupon Professor TAGGART called for more, and a barrel of the defective zinc oxide produced a couple of ounces of germanium sulphide. Here was a chance for some interesting work, and at the suggestion of Professor TAGGART an advanced student proceeded at once to a study of the periodic table. Germanium is in the carbon group, titanium and zirconium are respectively above and below it, and its near neighbor in the next, or nitrogen, group is arsenic, with atomic weight of 74.96, that of germanium being 72.5. What followed was suggested by the close relationship between arsenic and germanium in their respective positions in the periodic table, and in the behavior of the germanium dioxide in water, which resembles that of arsenic much more nearly than the oxides of the other elements of its own series. A stable saturated solution contains 0.004684 gram of germanium dioxide per 1 c.c. of water.

Then a test was made on guinea pigs by Dr. JOHN H. MUELLER and Miss MIRIAM S. ISZARD to see if a solution of the GeO_2 would increase the red blood corpuscles as does As_2O_3. The results were amazing, and they are reported in the March, 1922, number of the *American Journal of the Medical Sciences.* In all the animals treated the blood count went up over a million per cubic millimeter. With rabbits the same effect was observed. A big old dog weighing 142 lb., with the infirmities of age upon him and a blood count of about 2,000,000 below normal, was tried next. Old Rover got a little above 100 mg. of the aqueous solution injected daily for 9 days, and 234 mg. injected the thirty-second day. He developed a normal blood count on the third day, and 2 months after beginning he was still normal. The excess was eliminated in the urine. The next subject was a man 39 years of age who drank the GeO_2 solution half an hour before meals, and here again was the same effect. Lethal doses of arsenic are about 8 mg. per kilo of body weight, whereas that of germanium are over half a gram. Arsenic is also a cumulative poison, while the cumulative feature of germanium is negligible. It therefore does the work of arsenic, is only slightly toxic, and it looks as though means of overcoming pernicious anemia had been discovered. What organic compounds may be built up on germanium remain to be seen. They are at work over it in the John Harrison laboratory in the University of Pennsylvania and in the Wistar Institute.

Unfortunately we can not give more particulars at present, but the little we have learned goes far to show what a curious series of crosscuts chemistry brings into life. There was a batch of zinc oxide that went wrong. There was a live chemist in the works who knew his own mind well enough to stick to his conclusions until he could prove them one way or another. There was his loyal association with his *alma mater.* And now what follows bids fair to be a great contribution to the healing art.

Doesn't it seem worth while to keep good chemists around?

Containers for Coconut Oil

IT'S CURIOUS how hard it is to be up and doing in the tropics. And yet some of the most energetic men we know live under summer skies all the year around. They are, however, few in number. With most of us perpetual sunshine makes us dozy.

There is the copra business, for instance. According to *Commerce Reports* (Nov. 7, 1921) it is said that despite immense sums invested in coconut plantations, most of the groves of the Pacific are stifled with undergrowth and receive little cultivation.

There are oil mills in the Philippines, Dutch East Indies, Australia, the Straits Settlements and French Oceanica, and these have brought about a better quality of oil by avoiding deterioration of the copra in long transit. But these mills incur serious difficulties in finding good containers. Steel drums are expensive, wooden casks are unsatisfactory, and discarded kerosene cans, which are cheap in some localities, cause trouble in opening them and getting out the oil. Tank steamers present obvious disadvantages in shifting from an outward-bound cargo of petroleum to an inward-bound cargo of edible oil. That is, the disadvantages accrue to the edible oil rather than to the tankers.

This shortage of containers has caused a number of tropical oil mills to give up buying copra save at a fraction of the normal price, and accordingly a great deal of it has been shipped to Europe with the consequent deterioration in transit. It is curious that nobody has invented a cheap container for this valuable oil. Over here nobody seems to think of it, and out there in the tropics thinking is hard work. Maybe the hookworm is the obstacle that lies across the road to invention.

Permanence of Light Aluminum Alloys

DOUBT has been frequently expressed by engineers that light aluminum alloys can come into general use on account of their instability. For instance a British official who is best qualified to state an opinion has been quoted as saying, "Speaking generally, the aircraft industry had experienced great trouble with the alloys." Several instances of rapid corrosion, volume change and season cracking have been quoted, while apparently perfect pieces of duralumin have developed mysterious defects. Nevertheless it is unfair to condemn a metal because certain samples go wrong. Brass jars have been known to crack badly, standing on a shelf. Tin in storage has converted itself into dust. Steel castings have exploded with much fuss. But we have not yet discarded brass hardware, tin plate or steel wheels—the effort is rather to study the causes of the troubles and prevent their reoccurrence. So it is reassuring to read in the Eleventh Alloys Research Report—reviewed at length elsewhere in this issue—that the evidence of 9 years' study "indicates very clearly that the alloys do not deteriorate to any appreciable extent within that period of time, while in regard to retention of shape and dimension they are adequately stable for all purposes except for accurate standards of length."

Experience of years has therefore substantiated the theoretical conclusion that well-made alloys such as duralumin, "A," "E" and "Y" alloy, while they do change at room temperature, and continue to change for years, change in a way which enhances their usefulness rather than the opposite. If this be "instability," give us more of it!

Such alloys rank with steel in their susceptibility to heat-treatment. That is to say, proper heating and cooling will change the strength, hardness and ductility to such an extent as to suggest that an entirely new metal has been generated. They are unlike steel, however, in that changes in physical properties occur at room temperature—some steels will change perceptibly after a short stay in boiling water, but seldom is any change noted at atmospheric temperature. In other words, steel is stable in service; we believe that the strength which it possesses now will be possessed by the same metal after 50 or 500 years, if it is guarded against corrosion, heat or overstrain. Duralumin, "A," "E" and "Y" are unstable when quenched—that is, the physical properties determined a week later will be different than if determined immediately. It is said that they "age."

"Aging" is a rather unfortunate term, for it suggests the general deterioration of faculties as a man grows old. "Maturing" would be more apt, for the changes occurring in light aluminum alloys are similar to those which occur when a boy grows into a man—the boy ages; he also matures.

It is of course important that metallurgists and engineers should know exactly what these changes at room temperature are, in order that they may be able to predict the state of a maturing metal at some time in the future. Recent work on these alloys and on the theory of hardening makes it almost certain that the same kind of reactions go forward in heat-treated steel and in light aluminum alloys.

At the risk of stating well-known things, the analogy will be drawn in detail.

At elevated temperatures the normal constituents of an alloy which hardens mutually dissolve in one another, and distribute their atoms uniformly throughout the mass. With lowered temperature some of the constituents (cementite Fe_3C in steel and Mg_2Si and $CuAl_2$ in the light alloys) become insoluble, precipitate and accumulate into tiny hard crystals. Such reactions take time. If the cooling is quick enough, even the precipitation may be prevented—we fix the solid solution permanently in the cold metal if but a very small atomic movement is possible at the subsequently encountered temperatures. Such drastic chilling gives relatively soft metal—like quenched manganese steel. But anything which allows a little more atomic movement will allow precipitation of the insoluble constituents and their aggregation into minute crystals. Thus, hammering manganese steel hardens it almost instantly; gentle tempering does the same thing to other analyses which are austenitic when quenched.

Atoms comprising quenched aluminum alloys, however, seem to possess enough movement so that the precipitation and accumulation occur in metal at rest and at room temperature—the alloy hardens and strengthens continuously—rapidly for a few days, but continuing at a decreasing rate almost indefinitely.

It seems that maximum strength and hardness in metallic alloys are associated with a uniform dispersion of insoluble hard constituents of a certain size—if too small the metal is soft; as the particles grow the metal hardens; as the particles grow still larger the metal becomes again softer. Maximum hardness (that is to say, "critical dispersion") may therefore be had in two ways—by drastic quenching from the temperature range where all constituents are soluble followed by mild reheating, or quenching at a slower rate. Softer metal in turn can be produced by more prolonged or higher reheating, or by still slower cooling, either of which allows the insoluble particles to coalesce further into a smaller number of larger crystals.

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Automatic Processes In Industry

SCARCELY an industry in the country has made more than a start toward the utilization of the principles of mass production by automatic methods which were developed in the great metal-working plants and which have contributed so largely to putting them in their present high place in the world's industrial scale. We have been told that the methods applied to the working of metals cannot be applied so well to other materials and in most cases cannot be applied at all. The truth of the matter is that the particular machines used in metal working cannot often be used. The principle, which consists in the careful analysis of the operations of the non-automatic manufacture of the product and the translation of the results of this analysis into machinery which will duplicate the operations automatically, can be applied to almost any industry. There is a point, however, at which the size or complication of the machinery needed may increase its cost so much as to make its adoption uneconomical. But this is true in only a few cases, and we have no doubt that eventually almost the whole of industry will be on an automatic, mass production basis.

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No doubt we ought to regard the interest of posterity. Besides leaving coal in the ground, we should do well to employ our present capital and man power so as to leave the maximum of comfort and enjoyment in works of art, public and private buildings, transportation facilities, means of production and fertile soil.

In coal mining we have been wasting some coal, but there has been a vastly greater and more important waste of capital and of man power. The pity of the coal strike that began April 1 is that it will not dispel this economic evil. Everyone knows that there are large stocks of coal on hand and that the strike will not end until the stocks are depleted. Meanwhile man power is lost and capital lies idle.

Coal operators and coal miners use different language, but they say the same thing, that there are too many coal mines, and that means that there are also too many coal miners. The capital invested is not efficiently employed and man power is wasted. Repeatedly the coal miners have employed the strike as a means of passing on the expense of part-time employment to the public, the buyers of coal. In other words, they demand that the public support a partly leisure class, demanding a coal-mining rate that will pay an annual salary for a very limited amount of actual work.

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Readers' Views and Comments

Atomic Disintegration of Tungsten

To the Editor of Chemical & Metallurgical Engineering

SIR:—The note in your issue of March 22 on "Atomic Disintegration of Tungsten" is of extraordinary interest, and a few comments may be justified.

It is said that the method employed was suggested by astronomical researches at the Mt. Wilson observatory, and I infer that the experimenters have ingeniously obtained, in the laboratory, conditions approximating those resulting from collisions of dark stars or similar bodies in the vacuum of intersteller space. When such collisions take place, there of course occurs a prodigious transformation of kinetic energy into heat of intensity that might easily reach or surpass the filament temperatures calculated by Drs. Wendt and Irion. The solid elementary masses of the colliding bodies thereupon explode like the tungsten filament of the experiment, with incredible violence, the main product always or usually appearing in the spectroscope as hydrogen. This gas, if I remember correctly, was driven off from the nucleus of Nova Perseus at a speed exceeding that of any observed solar protuberance and which remained as our record of the highest velocity obtained by matter until that of the helium alpha particle from radium so far surpassed it. Whatever the results of the work prove to be, all must honor the vision and ingenuity by which cosmic conditions have been so nearly reproduced on a laboratory scale.

The outstanding feature of the report is that tungsten of atomic weight 184 has been transmuted to mercury of atomic weight 200.6. Here is something entirely new; for all the long series of elementary transformations familiar to the student of radioactive phenomena involve a lowering of individual atomic weights. It is not of record that either by natural degradation or from alpha particle bombardment an element has been changed into another of higher atomic weight. A key to the answer may be found in that word "degradation." From the supposed beginning in U or Th, to the ending in Pb or an isotope, each step of radioactive elementary transformation apparently consists of a drop in individual atomic weights, with *liberation* of energy. Admitting this, it is conceivable that from an intensely applied source of supercalescence an atomic system might *absorb* energy, and that, doing so in the work under consideration, some multiple of W (184) may have been energized into some multiple of Hg (200.6); a sufficient amount of H (1) and He (4) being freed to complete the equation.

This would be an "ennobling," in sharp distinction from the "degradation," or loss of potential energy, involved in all previously observed elementary transformations. It would more closely meet the general conception of the term "transmutation" than anything heretofore accomplished.

I may be excused for suggesting that this unique reversal in the direction of atomic weight alteration, however capable of speculative explanation, perhaps casts a shade of doubt on the results that might not otherwise be felt and that all will eagerly wait to see removed. In this connection I venture to mention the possibility of H or He occlusion or inclusions in the metal of the W filament used for the experiment. It is of record that these cause trouble in the "hard" type of thermionic valve radio tubes; the gases being slowly liberated from the W of the filament even after its painstaking purification and under the comparatively mild conditions there existing. Spectroscopic evidence of Hg, also, needs a rigid "third degree" when observed in connection with any form of exhausted-tube apparatus. I apologize to Drs. Wendt and Irion for bringing up these points if, as is probable, they have already been considered. DALTON M. GOETSCHIUS.

The Standard Chemical Co.,
Canonsburg, Pa.

When Does an Employment Contract Terminate?

To the Editor of Chemical & Metallurgical Engineering

SIR:—I know of no remedy at law for unfortunate engineers or technical men who have, in good faith, signed a valid employment contract before entering such employment. If employment is entered into without such a contract and later the employee is asked to sign a contract which imposes unsatisfactory conditions and is given to understand that his services will be no longer required if he does not sign such a contract, there may or may not be an element of coercion.

In my opinion, the real remedy for such conditions as you have described in your editorial of Feb. 22 lies in the proper education and enlightenment of the engineer or technical man. For years American engineering and scientific schools have prepared their graduates to render not only valuable and efficient service in the everyday duties that they are employed to perform but they have also given them a training which has cultivated the inventive or initiative faculty and foresight to a greater degree than can perhaps be acquired in any other course of human training or experience. Unfortunately engineering and scientific schools have not in the past and still do not, so far as I can learn, attempt to impress upon their students the value of such inventive or creative talents.

On the other hand, these schools have inculcated in the minds of their students a spirit of loyalty to their employers and the strict observance of a code of moral and professional ethics. Without deprecating the inculcation of loyalty to one's employer or the observance of proper moral and professional ethics, it is my opinion that the engineer or technical man who is guided by these high principles in making an employment contract is at a tremendous disadvantage in dealing with the average employer, whether such employer be the sole proprietor of his business or merely an official of a corporation. Unfortunately for the engineer seeking employment, the business-man employer generally has only one motive, and that is to make the best bargain possible. That is the only code of ethics with which he is familiar. He is, however, well aware of the high principles and code of ethics which actuate the average engineering graduate and generally takes advantage of them.

From a legal viewpoint and from the generally

accepted brief code of business ethics which I have above mentioned, the employer is probably within his rights in driving a hard bargain. If the employee does not desire to accept employment under the conditions proposed by the employer, he does not have to, and if, after being employed, the employee is required to accept further unsatisfactory conditions or get out, he is still at liberty to make his choice. Engineers should understand this and also understand that alluring prospects for promotion and for sharing in the profits of his employer are will-o'-the-wisp-like unless written into a contract in plain, unmistakable language that such promotion and sharing of profits are considerations of the contract.

Unless, therefore, the technical man knows the value of his wares and has the courage to demand a fair price for them, he is likely to be the victim of the employer, who, though he may have no knowledge and have no ability to acquire knowledge of technical matters, possesses superior faculties and has had infinitely better training in the knowledge of values and the analysis of character.

If the technical man will stop to consider that many of the large employers of engineers who exact the signing of employment contracts calling for the assignment of all patents or inventions of their employees for no other consideration than that of their wages and employment carry their patents and inventions on their books at an enormous capitalization and use these patents as the means of maintaining a virtual monopoly of their business and, incidentally, of maintaining high prices, such a technical man, from the training he has received, ought to be able to judge the value of his inventions. If he is contributing to the aggregation of patents owned or controlled by such an employer, he should insist upon receiving reasonable compensation for such as he contributes. If he does not insist upon such compensation, he should not later complain that his contract of employment is unjust.

Engineering and scientific schools can do much to alleviate the situation by teaching their students the value of technical service particularly as relates to patents and inventions and teaching them also that the product of their brains is their natural heritage and that they should not sell it for a mere "pot of porridge."

I do not agree with the statement made by W. S. Landis in his discussion of this subject which appeared in your issue of March 15, that "raising of the ethics of the profession would go a long way" toward making unnecessary the form of contract under discussion. The ethics of the profession are already on such a high plane that he who is governed solely by them when negotiating for the sale of his services has an insurmountable handicap.

Nor can I conceive of a just "comprehensive and adequate patent law whereby the granting of a patent assumes novelty, without the burden of adjudicating the same through litigation." It is obvious that if one be deprived of the right to contest the validity of a patent, the Patent Office would have to be infallible, else injustice would be done in some if not many cases. It is humanly impossible to be infallible, and our wise and altogether admirable laws governing the issuance of patents therefore provide for relief where injustice has been or is thought to have been done.

Cleveland, Ohio. FRANK L. SESSIONS.

Philip Argall—A Case of Parallel Invention

To the Editor of Chemical & Metallurgical Engineering

SIR:—The late Philip Argall of Denver, Col., whose untimely passing was noted in your issue of March 29, was a remarkable man. I was well acquainted with him when I held the chair of chemistry at the State University of Colorado, at Boulder; and I am indebted to his fertile and original practical scholarship for many a help. Mr. Argall was far ahead of most of his profession, in mining, milling and metallurgy. It was his bold suggestion that first reduced the resistant Cripple Creek ores, the "tellurides," to subjection in cyaniding. That the tellurides are one of the few cases where gold occurs combined chemically has long been well known. That these tellurides can be easily roasted has also been well known. Thus in the old days of rich specimens, it was common to make show pieces by simply placing the raw ores in a fire, when the tellurium would volatilize off, and the gold would "fry out" in great drops all over the specimen. But it was Argall's brain that saw that the reason raw telluride ores would not cyanide was that the cyanide could attack only free gold; and a simple roasting of the telluride sets the gold free. Mr. Argall put this into practical working at the D. Moffat Works near Florence, Col., back in the '90s. In connection with the recovery of the gold from the cyanide solution, zinc shavings were used to precipitate the metal; but Mr. Argall tried scores of other possibilities.

While he was deep in the midst of that work, I recall that he made me a visit at Boulder, in the course of which we had many a confidential discussion of chemical ways and means. One day he told me, with emphasis of the need of secrecy, that he had succeeded in making common metallic aluminum active, about as active as sodium amalgam, when immersed in water, by the action of such salts as those of mercury or metallic mercury, or both. I listened with no small degree of interest, for that was a new reducer worth attention; but as I did not seem to be as much impressed as he had expected, he paused to hear my reply. I went across the room to the last file of *Berichte*, and showed him the identical discovery, just published in the last number, by Prof. Wislicenus of Leipsig, who had worked out the same invention from the standpoint of organic chemistry. Of course Mr. Argall was almost dumfounded, for he said that I was the first man to whom he had trusted any word of his discovery.

On questioning Mr. Argall and on looking up the date of the receipt of Prof. Wislicenus' manuscript, it appeared that those two men, one in Leipsig, Germany, and the other in Florence, Col., had evidently made the parallel invention within a few days of each other and from entirely different points of attack, one inorganic and the other organic; one from the heart of an old and well-furnished university laboratory and the other in the midst of all the trials and distractions of a workshop. This must have been in the late '90s.

The incident is only one of many showing that new inventions are always in the minds of several men; but it is not often that one has the opportunity to check up the facts in such an incontestable way. The episode shows not only the brilliant working of the inventive mind of Philip Argall but it also throws some interesting light on the close connection between fields of research apparently far apart.

Pittsburgh, Pa. CHARLES SKEELE PALMER.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, March 18, 1922.

CHEMICAL markets are still somewhat uninteresting and although the trend of prices is in a slightly upward direction, this is due more to depletion of stocks than to substantial business. Fertilizers, as mentioned in last month's notes, continue to be an exception, and sulphate of ammonia is almost impossible to obtain for early delivery. Glacial acetic acid is again in demand and a further rise in price is predicted, chiefly owing to failures to make delivery from the continent. The lockout in the engineering trade is not expected to last more than 2 or 3 weeks, but even if a prolonged stoppage is avoided, the effect on the chemical industry will be noticeable, a slight setback nowadays making a relatively deep impression.

SUCCESS OF CHEMICAL EXHIBITS AT BRITISH INDUSTRIES FAIR

It seems unnecessary to deal at length in these columns with the magnificent exhibition organized in London and Birmingham under the auspices of the Department of Overseas Trade. Full reports and comments have appeared in the *Chemical Age* (London) and the *Times Trade Supplement*, while some excellent impressions of the fair appeared in the *Journal of the Society of Chemical Industry* this week. The writer has paid several visits to the fair and the essential point about the chemical exhibits was that perhaps for the first time in this country there was a real attempt at organized as distinct from haphazard presentment. For this credit is undoubtedly due to the Association of British Chemical Manufacturers and instead of a duplication of exhibits, the keynote was specialization and concentration on specific lines not competing too actively with other manufacturers represented at the fair and very often covering some special brand or quality. It would be invidious to refer to any specific exhibits without dealing with all of them, but the fine chemical industry as a whole certainly rose to the occasion, and particularly as regards purity the exhibits reached a very high standard. A particularly British characteristic is the continued existence and progress of relatively small firms, which either alone or as constituent parts of an organization demonstrate that individual effort and initiative upon which the trade of this country was founded have not been entirely eliminated by the wartime tendency of amalgamation. Dyestuffs were well to the fore and a very complete and up-to-date collection of finished manufactures using dyestuffs aroused great interest and compared very favorably with similar exhibits seen by the writer last year at the Chemical Exposition in New York. In fact the method of presentment was perhaps better, even if the range of colors exhibited was not quite so extensive. The size and scope of the fair as a whole may be judged by the fact that in London alone there were somewhat less than 1,000 exhibitors, taking a total space of 200,000 sq.ft., the actual frontage of the stands being over three and a half miles. Even if these notes are concerned chiefly with the chemical exhibits, the remainder of the fair was most illuminating and gave a comprehensive picture of present trade tendencies and of real progress in almost all branches of British manufacturing activity. Exhibitors appear to be well satisfied with the results obtained and are likely to give increased support next year. In addition, there was ample opportunity, apart from the business of securing orders, for exhibitors to become better acquainted by interchange of views on the spot and some interesting developments are expected. Although only about one-twentieth of the whole, the chemical exhibit was generally regarded as the outstanding feature of the fair and its educational value to the public and to the legislature has been appreciable. It will not be out of place to mention that only one of the chemical trade papers really made a feature of giving its fullest support, while the older established journal seems to have failed in its duty as a handmaid to the industry.

FURTHER DECISIONS UNDER SAFEGUARDING ACT

It was decided today that tartaric acid, cream of tartar and citric acid are not fine chemicals and in consequence they will not be subject to duty. Apparently the evidence of foreign manufacturers was accepted in preference to that provided by members of the Association of British Chemical Manufacturers, and speaking broadly, it is thought that in view of the large quantities handled annually, it might even have been possible to classify some of these products as heavy chemicals, although it was not part of the referee's duty to apply any such definition. A further decision was that in the case of lactose, which under the act was subject to duty, whereas Allen & Hanbury, Ltd., claimed that it was really a food, that its manufacture did not call for more skilled chemical supervision than, say, cane sugar and that such supervision was not such as would enable the product to be called a fine chemical. As a result lactose has been struck out of the list of articles subject to duty and general opinion seems to indorse the referee's view.

GENERAL NOTES AND NEWS

The organizers of the proposed Institution of Chemical Engineers have made rapid progress and the drafts of the articles of association and of the bylaws have already been circulated to the advisory committee, which consists of more than one hundred prospective members. The Institution should come into being during the next few weeks. It has been well supported financially and otherwise by the leading members of the profession. It will be noticed that the word British does not enter into the title selected for the Institution and the standard which has been set by those responsible will render it worthy to rank in every way equally with the pioneer American Institute. Some confusion has arisen as to its relationship with the chemical engineering group of the Society of Chemical Industry, but clearly there is no connection, the former being a qualifying and examining institute, while the latter should work in close co-operation and function more particularly as an educational body.

The Plauson colloid mill referred to in my January notes is making further progress, the necessary financial and technical support having been forthcoming, and interesting developments are expected in the near future. It will be remembered that some months ago Plauson, in conjunction with Vielle, took out a very large number of provisional patents and the publication of complete specifications should soon begin.

The Alby United Carbide factories is now definitely being wound up, the negotiations with the Barton group having failed.

The Business Side of Chemical Manufacturing

The First of a Series of Articles Discussing the Non-Technical Departments, Their Shortcomings and the Usefulness of the Technical Man in These Fields—The Organization—The Purchasing Department

BY CHARLES WADSWORTH, 3D

CONSIDERABLE attention has recently been focused on the fact that chemists and chemical engineers know so little about the business side of chemical manufacturing. Perhaps it would be more accurate to say the non-technical side of chemical manufacturing, for it includes practically all phases of the manufacturing business which are not strictly technical. For these things there is practically no preparation in technical schools. It is therefore excusable, perhaps, that the technical man should fail to realize the importance of the non-technical at the start of his career. That he should continue to ignore it is unfortunate for the industry and for himself. To drive home to the technical man the vital importance of the field he is neglecting is the main purpose of this discussion. As a corollary it is hoped that employers may be made to realize that technical men possess qualities which are distinct assets in the non-technical side of chemical manufacturing as well as in their special fields.

RELATIVE IMPORTANCE OF NON-TECHNICAL DEPARTMENTS

How important is the non-technical side of chemical manufacturing? To arrive at this, let us first consider a theoretical organization. There are eight departments into which the work is usually divided. They may be regarded as the "elements" of organization. They are:

1. Research and development.
2. Operating.
3. Engineering (maintenance and construction).
4. Purchasing.
5. Sales and credit.
6. Advertising.
7. Accounting.
8. Finance.

You must understand that the problem of every organization is different and that the relative emphasis placed on any given department will vary tremendously. A dye plant, for example, will have to have seven research chemists, where a sulphuric acid plant of the same financial size will have none. Again, in a plant which produces large tonnage the chief engineer is likely to be a very much higher priced man than in a plant where the mechanical factors of production are small, and so on. In large organizations subsidiary departments, such as traffic or credit, often become important enough to enjoy separate existence. But every healthy chemical manufacturing plant will have all of those eight departments represented. The aims of each department are under constant scrutiny by the best executives. In fact it may be said that the principal executive effort should be the discovery of fresh ideals and stricter standards for the elements of his organization, in accordance with the principle of balance of which we shall have more to say in a little while.

In the list given above there are three technical departments and five non-technical departments. Is that not food for thought? Five to three! Please let me forestall any argument about the technical department being more important. "What would become of the business if it was not for the discovery of the process and the production of the goods? Where would the business be?" That has a good sound, but the answer to it is, "Just exactly where it would be if you couldn't sell the product, if you did not know accurately whether you had made money or not and if you did not know how to handle money! Nowhere!" Talk to executives about the situation. Consider why it is that in the long run the purchasing agent, the sales manager and the auditor get as much salary as the head of research, the operating superintendent and the chief engineer—sometimes more. What is the answer? That only three-eighths of the business of manufacturing chemicals is technical. Indeed in arriving at this figure we have assumed that all the work of the technical departments is technical, which is far from the case. But we are interested only in bringing forward the fact, novel and a little bitter for the technical man, that non-technical work is more important to the organization than technical work.

Strength and Weakness in an Organization

Before we undertake a detailed study of any of the individual departments, it will be worth while for us to consider the organization as a whole and to bring to light any generalizations as to causes of strength and weakness. It will give us a better perspective through which to gage each element of the organization. Organization is a human machine and its problems are the problems of the human equation. Retaining our analogy to a machine, we can say that an organization to run smoothly must be well balanced and that its parts must be in good condition. Lack of balance indicates weakness, just as balance indicates health. In studying a particular organization to determine its specific weaknesses (for every organization will have weaknesses—it is inevitable, since its elements are human beings) the best way to proceed is to study routine. With a knowledge of normal routine it is comparatively easy to locate departures from it. Sometimes these departures indicate executive wisdom but more often a lack of understanding of the functions of a given department.

The best way to understand this is to study specific cases. If we follow a purchase requisition through from its origin until the purchase order is ready to mail, we shall discover who the big men are and what departments are not functioning properly. We may

find that some one who is not the purchasing officer carries out the negotiations. A requisition for a specific piece of apparatus is turned in to the purchasing agent, who then transcribes it on the purchase order form. This means that the purchasing agent is nothing more than a clerk and that his department contains only a small part of the invaluable data which it should contain.

Again, how are the data of the accounting department obtained? Are the forms designed for its convenience or does it have to glean information from operating department forms? Are its reports turned in on time or is there delay in making them out? In obtaining answers to these questions we shall be able to determine whether the accounting department is being treated with proper respect or whether the factory men regard it as a nuisance and adopt a condescending attitude toward it. Still again, a decision to shut down a unit in the plant is made. Who makes it? Who is consulted? Does the superintendent say "please" and "sir" to the chief engineer or does he forget to warn him that less power and steam will be needed? All of these things are indicators. They show us very conclusively whether there is a lack of balance in the organization and where a corrective is needed.

Weaknesses of the Executive

There is another type of weakness in organizations not due to the departments but to the executive. This weakness—the weak executive—may take a number of forms, but there are three which are especially common and therefore deserve mention. The first has already been mentioned. It has to do with lack of familiarity with non-technical departments on the part of technical men. Unfortunately, the technical man who becomes an executive is not an exception to the rule. He is made an executive largely because he is familiar with company procedure or because he is the logical man to promote. After his elevation he becomes absorbed in the routine of his position and does not feel called upon to round out his experience in other fields. The technical man who is head of his own business is, on the other hand, even more apt to become wedded to bad practice in his non-technical departments.

The second type of weakness in executives consists in a belief in the dignity of executive office. This manifests itself in a reserve toward subordinates which kills any possibility of intimacy and therefore closes the most perfect contact which the executive has with his organization. Without it he has no way of discovering what is happening, what dissensions are brewing, what ill feeling exists. Weaknesses that appear in his organization are often a matter of distinct surprise to him.

Lack of Consistent Policy

Finally, the third weakness consists in a lack of consistent policy. Vacillation is perhaps the most disrupting thing that any organization can have. It may be the fault of the board of directors or it may be the fault of the executive. Perhaps it may be that a department is created and then given up. Perhaps men are taken on for a special purpose and in a few months are discharged arbitrarily. Perhaps the change may be only the rerouting of an office form and then a switch back to its former route. Whatever it is, little or important, it affects the morale of an organization. Only those who have experienced such things can realize how serious it is. Vacillation must in no way be confused with the progressive changes which a good executive introduces. An organization is very quick to recognize the difference between progress and vacillation. Too often expediency is the evil genius of the executive.

All of these things tend to create a lack of balance in the organization and balance is the name we have given to the principle which keeps the organization in smooth equilibrium. Your organization may consist of one man who is simultaneously the head of every department or it may be so large that hundreds of men are necessary to accomplish the routine. This principle of balance is just as inescapable for the one as for the other.

The title of this article is the Business Side of Chemical Manufacturing, so let us get back to the subject. Perhaps we are in a better position to discuss the details of the various departments by reason of our digression. We shall try to develop the aims of a normal department and discuss the methods by which the work is accomplished. We shall try to show that technical training is of great assistance when it is given the opportunity. Perhaps we shall be able to indicate definite ways in which technical men may become familiar with the work of non-technical departments. (By this I do not refer to business courses, but I want to take this occasion to indorse such courses when given by reputable organizations. A technical man can go very far without finding a better paying proposition than a reading course in Modern Business Methods or a night school course of the same kind. That is personal experience.) Finally, there may be an occasional idea advanced in the line of enlarging the scope of existing departments to include functions which have been discarded.

Perhaps it has already occurred to some of you that the word technical training was a happily vague phrase which covered a multitude of sins. It is. There are many sins, too. I have encountered technical training which was not worth as much as a good grammar school education; but, vague though it is, the phrase has certain connotations and means, if nothing else, familiarity with scientific vocabulary and method of work.

The Purchasing Department

The purchasing department buys raw materials and equipment for the business. In order to do this, it is necessary for the department to know:

(1) Specifications—what to buy!
(2) Consumption—how much to buy!
(3) Markets—when to buy!
(4) Transportation—where to buy!

This seems rather elementary, and yet it is in those four words that we can condemn the average purchasing department today. A purchasing agent is very likely to know the market for raw materials which are used in his plant and he is apt to know something about transportation. But if he knows anything about specifications or consumption, it is so much parrot talk and he doesn't *know* it. He is usually woefully weak on new equipment, for he does not understand it, and is unintelligent on the general stock of material which is kept on hand. Let us consider some of the things which lie behind the four words given above.

It will be easier to study by the case method and so

we will watch a well-organized purchasing department act in the purchase of a piece of equipment and then in obtaining a supply of raw material.

Equipment

A manufacturing department sends in a requisition to the superintendent's office for a kettle. It is sent on with his O.K. to the purchasing department. It is perfectly safe to assume that the details given about the kettle are insufficient to complete the purchase, so the first thing that must be undertaken is the completion of the requisition by conference with all of the interested parties. This may include the engineering department, and a blueprint of the kettle may be forthcoming. It is even possible that this was turned in with the requisition. In any case the purchasing agent first puts himself in possession of all the data that are available and he then knows the material preferred, the probable corrosion, the pressure under which it will be operated, whether there is to be a jacket or a coil, and the dimensions and details thereof. In addition he knows the kind of stirrer desired, number of revolutions per minute, kind of driving mechanism, outlets and inlets to the jacket and kettle and so on. It can honestly be said that the efficiency of the purchasing department in making this purchase will depend upon the thoroughness with which the details of this equipment are mastered. I do not mean memorized, but understood; so that the purchasing agent can of himself make or authorize changes in the specifications.

Consulting the Card Index

And in the meantime the purchasing agent has been consulting a file of cards, labeled "Equipment." On the card labeled "Kettles" there is listed all those firms which are in a position to supply equipment of this type. An appropriate mark identifies each firm as having estimated previously on similar work or as having supplied equipment before. The most promising firms are looked up in an additional catalog of firms alphabetically indexed. These cards contain a history of the purchases made from a given firm with comments as to whether the transaction was satisfactory and whether the equipment was reliable. If the kettle is a replacement, another index is consulted called the plant ledger which gives a history of that particular piece of equipment on one of its cards. A similar history of every important piece of apparatus in the plant is contained in this index. Finally, a file of manufacturers' catalogs is searched for additional information. This completes the investigation in the organization.

Sending Out Inquiries for Bids

The purchasing agent is then ready to send out inquiries. The method of canvassing the market for material is thoroughly well known and yet withal very poorly done. Ask anyone who has to quote on material or equipment how easy it is to understand the average letter of inquiry except where no confusion is possible. As the bids come in, it is sometimes a really difficult thing to determine whether everyone is bidding on the same equipment. A separate file is often kept on which the data obtained from answers to the bids are summarized. Finally, after the purchase order is made out and sent, a copy is retained in the purchasing office on which to keep a record of the follow-up work which is done. This follow-up consists in ascertaining whether the time of delivery on the original contract is to be adhered to and perhaps in following the freight shipment after it has left the supplier.

A word at this point on purchase order forms is not out of place. Too often these forms are miserably designed. Study those that come in from the outside some time and construct a form which will be satisfactory, complete and clear. The best forms often belong to dealers or traders who are not producers. Purchasing is even more vital to them than to manufacturers, for it takes the place of their production department as well as occupying its own important functions. Some large corporations are cursed with the most inefficient, vague forms that exist. It is a minor point, but one which reflects the finesse and technique which has been put on the purchasing effort.

Can you see in the purchase of that kettle where a technically trained man would have an advantage? How much easier it would be for him to understand specifications and to make sure they were complete? How much easier it would be for him to decide whether the differences between two pieces of apparatus estimated by competing firms were serious or minute?

Raw Materials

Now let us follow the same department in the purchase of a quantity of raw material for the plant. As in the case of the kettle, the requisition may originate in one of the departments, but more likely it originates in the purchasing office itself. A file of stock cards, one card for each material, shows purchases, receipts and consumption daily. It may also contain such other information as the origin of the material, chemical analysis, usefulness, etc. When the stock of material as shown by the cards reaches a certain definite minimum, which may be a month's supply or only a week's supply, the purchasing agent puts through an order for more material. He may get it from a single source or he may shop for it (that is the name given to the method of purchase followed in buying the kettle). Quite frequently raw materials are contracted for on a yearly basis, though seldom in the last 2 years for many obvious and grim reasons. On the other hand, even in normal times with steady consumption, the purchasing agent often prefers to take a chance on the spot market, which means immediate purchase. Otherwise, the system is the same as already outlined in the case of the kettle.

Pitfalls for the Purchasing Agent

Oftentimes this kind of purchasing is very intricate. The specifications for chemicals may be negligible. They may be standard throughout the trade. They may, on the other hand, be very special, based perhaps on a definite percentage composition. Indeed the method of analysis is often of necessity the crux of the whole purchase. Again, do you see that technical training would have value? Consider this. Can your purchasing agent decide of himself that the analysis giving 93 per cent material had been properly carried out? Can he talk to the referee about the technique of the method? If he can't, consider my friend, Smith we'll call him, who lost $10,000 on one purchase through just such an error. He did not know exactly what the per cent analysis meant, although he thought he did.

Another memory! Purchasing Agent Jones made a very advantageous buy of a heavy chemical on the

spot market. The material began to come into the plant and the available storage space at the point of consumption was soon used up. Other storage space about a half mile from the consumption point had to be utilized. When the raw material stored at a distance was being consumed, the increased cost of handling boosted the cost of raw material well above the price of that material then on the spot market. The advantageous buy turned out to be a very poor buy.

Still again, on a contract for a large number of cars of raw material each month shipment was usually made all at once. These cars arrived about the same time and in order to avoid demurrage to the railroad they had to be unloaded immediately. If they had arrived even approximately at a given rate they could have been unloaded so that the material would be consumed straight from the cars. This would have avoided a rehandling charge and saved several cents per hundred pounds.

The Tragedy of Inefficient Purchasing

Such errors are unfortunately very common. They are typical of a large number of mistakes in purchasing which have come to my personal attention. You will realize that very many of these would pass unnoticed in an organization. That is the tragic part of inefficient purchasing, that no one realizes that it is inefficient. Neither of these two problems has ever been completely solved, but that only adds zest to the game.

The purchasing agent must also know a good deal about transportation. This includes not only a knowledge of routes so as to obtain best deliveries for materials in transit, but ability to follow up shipments on the way to the plant, to trace lost cars and understand the recovery of damages from the railroad for losses in transit. Sometimes when the company is large enough there will be a separate traffic department, but that will not relieve the purchasing agent of knowing some transportation.

Interviewing Salesmen

Not infrequently purchasing agents will regard salesmen as a cross between a nuisance and a performing dog. He will instruct them to call between 1 and 1:30 on Mondays, Wednesdays and Fridays or some such arbitrary time. When he does see them he makes the salesmen perform under difficulties. A brusque, testy air which keeps salesmen hurried and ill at ease! It was very aptly described by a good friend of mine as the "horse-trading attitude." The result is that oftentimes the purchasing agent loses an important message. Salesmen are his antennæ, his contact with industry and progress. It has always seemed to me that here was the purchasing agent's main job: to know salesmen, to make friends with them, to know their products. The stories are too numerous to count of the salesman who has delighted in slipping one over on the rough horse-trading purchasing agent. Courtesy pays in more ways than one. When a purchasing agent knows more about the product than the salesman does, then he may be justified in being brusque. How many purchasing agents are there who can do this? Practically zero. And yet I have seen salesmen dismissed curtly by a purchasing agent who could not have mentioned a single use for the product, without even attempting to discuss the comparative merits of its competitors.

In addition to salesmen, purchasing agents have a few other antennæ out in the world. One of the most useful is the advertisements in the technical magazines. These and the excellent Chemical Exposition at New York will keep him remarkably well informed. If a technical man wanted to be better informed than almost any purchasing agent, at least in the matter of equipment, he would need to do little more than keep up on advertising in the technical papers. It sounds simple, doesn't it? You would almost imagine that a great many technical men would take advantage of this very simple procedure, but they do not. Ninety per cent of the technical men whom I know cannot take a single piece of equipment and give a decent résumé of the different types on the market, mentioning the relative advantages and disadvantages of each. Ninety per cent is not estimate, it is count. How about you? How many pieces of equipment do you know? As a technical man you cannot be sure that your process is running at its maximum efficiency if you do not know equipment. The same thing is also true if you do not know the raw material market.

And yet, with all their ignorance, technical men have understanding which would be of great service, if properly developed, in a purchasing department. Of course, if your company has only a clerk who is called purchasing agent, while the actual work of negotiation is carried out by the superintendent or the chief engineer; a purchasing agent who merely transcribes requisitions onto purchase orders, then they will not need, nor will they understand the need of a technical man in the purchasing department. But they are losing the invaluable asset of centralized control of purchasing with all the vast store of knowledge which would accrue from it.

Technical Brains Needed in the Purchasing Department

Any well-organized purchasing department needs technical brains. I do not mean that a technical man is fitted, *a rerum natura*, to take charge of a purchasing office. Not without an adequate preparation in the technique of purchasing which is intricate, difficult and vital. But I suggest this prescription to any technical man who is doing a technical job and who is perhaps a little discouraged at the prospects. Ask the boss if you can't do some purchasing. Take a job as clerk in the purchasing office. Never mind the salary! Ask if you can't meet the salesmen. Start some of the card indexes mentioned in these paragraphs. Collect all of the catalogs you can and know the products. Read the advertisements in the technical magazines. If the purchasing agent is a good one, you will be his right-hand man inside of 2 years. If not, you will either have his job or be qualified for a job with a corporation where a good purchasing agent is appreciated. It will be interesting. Try it.

Perhaps you are an employer and have a purchasing department. Has it all the functions it should have? It hasn't? But you can't put any more responsibility on the present incumbent? Well, try a young technically trained man! Lord knows they are cheap enough. Give him a conception of the way to handle a purchasing department and then turn him loose. I will gamble the result will not be disappointing.

Finally, as a technical man, you should realize that purchasing is a vital function of your business and that you must understand it.

Chicago, Ill.

Contributions to the Study of Ammonia Catalysts—V

The Concluding Article of This Series, Which Takes Up in Detail the Effect of Pressure on Catalytic Activity as Determined by the Fixed Nitrogen Research Laboratory*

By ALFRED T. LARSON

IN MAKING a preliminary study of an ammonia catalyst, one is first concerned with the activity of that material at different temperatures and pressures. If the activity is reasonably high, it then becomes important to consider such factors as longevity and recovery from contact with poisons. But activity tests must come first. In order to examine a large number of catalyst materials, activity tests ought to be easily and inexpensively made. Now, testing at low pressures, particularly 1 atmosphere, is relatively simple and rapid. This method would therefore provide the most convenient way in which to study the activity of ammonia catalysts, provided, of course, that the behavior of such catalysts at high pressures could be predicted from results at low pressures. If this were feasible, it would then be possible to avoid the more laborious and expensive high-pressure testing.

In the preceding paper of this series, it was intimated that the decrease in efficiency of ammonia catalysts as the pressure is increased is much greater for some catalysts than for others. That is, if the tests at low pressure, say 1 atmosphere, show the catalyst to be very active, it may not be safe to assume that this catalyst will be equally efficient at higher pressures. It will be the purpose of this paper to present the experimental results which have been obtained in testing a variety of catalysts, and to show to what extent results of tests at low pressures are useful in predicting their behavior at higher pressures.

Apparatus and Procedure

In earlier papers we have called attention to some of the difficulties which must be faced if exact information concerning the behavior of ammonia catalysts is to be obtained. The need for known regulation of temperature, pressure and purity of gas cannot be too strongly emphasized. Unless all the factors which influence the behavior of a catalyst are under proper control, one cannot hope to obtain comparable results. Therefore, in studying the effect of pressure on a variety of ammonia catalysts, we have attempted, in so far as our present technique would allow, to establish complete identity of conditions. By carrying out all the tests on the various catalysts within bombs of the same type, all of which have been found to be strictly comparable; by employing the same instruments and regulating devices in all tests; by operating on the same purified gas and by reducing all catalysts under the same conditions of temperature and pressure, it is believed that identity of conditions has been obtained.

The apparatus employed in this investigation was described in article II of this series.[1] The arrangement of the apparatus was given in Fig. 1, while the details of the catalyst bomb were given in Fig. 4. This equipment was specially designed to give complete identity of conditions and to be capable of operation at any pressure up to 100 atmospheres. The four bombs employed in these tests were found to give the same results when operating on the same catalyst under the same conditions of temperature and pressure.

The catalysts, all of which were iron oxides with different kinds of promoters, were reduced in a 3:1 mixture of hydrogen and nitrogen at 1 atmosphere pressure and the following temperatures: 24 hours at 300 deg. C., 24 hours at 350 deg. C. and 24 hours at 400 deg. C. At the end of the third day the temperature was raised to 450 deg. C. and the ammonia samples taken at regular intervals until the conversion became constant. All catalysts were tested at a temperature of 450 deg. C. and at pressures varying from 1 atmosphere up to 100 atmospheres. Each catalyst was tested on pure, dry gas, and on pure gas humidified at 25 deg. C. and 100 atmospheres pressure. This gave a gas containing 0.031 per cent of water. The purification of the gas and the method of its humidification were described in article II of this series.

Summary of Results

In Table I we have summarized the results of tests on eleven catalysts, the pressures being 1, 10, 31.6 (450 lb. gage pressure) and 100 atmospheres.[2] The table includes the performance of each catalyst on both dry and wet gas. In each case we have given the actual

[2]The experimental work for this paper was done by A. P. Brooks, F. E. Smith and L. A. Stengel.

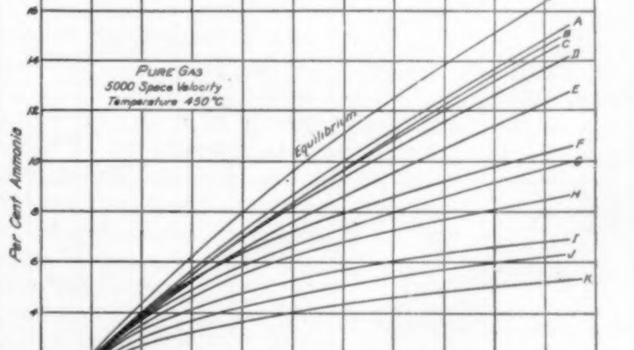

FIG. 1—EFFECT OF PRESSURE ON PER CENT OF AMMONIA USING PURE GAS

*For Parts I, II, III and IV see Chem. & Met. Eng., vol. 26, Nos. 11, 12, 13 and 14, pp. 493, 555, 588 and 647, March 15, 22, 29 and April 5, 1922.

[1]Chem. & Met. Eng., vol. 26, No. 12, pp. 555-560, March 22, 1922.

TABLE I—TABULATION OF RESULTS OF TESTS ON ELEVEN CATALYSTS SHOWING EFFECT OF PRESSURE ON PER CENT AMMONIA AND CONVERSION EFFICIENCY

Pressure Atms.	A Per Cent NH_3	A Eff.	B Per Cent NH_3	B Eff.	C Per Cent NH_3	C Eff.	D Per Cent NH_3	D Eff.	E Per Cent NH_3	E Eff.	F Per Cent NH_3	F Eff.	G Per Cent NH_3	G Eff.	H Per Cent NH_3	H Eff.	I Per Cent NH_3	I Eff.	J Per Cent NH_3	J Eff.	K Per Cent NH_3	K Eff.
Pure Gas																						
1	0.223	96.5	0.206	89.5	0.202	87.3	0.204	88.7	0.216	93.0	0.225	97.0	0.227	98.0	0.232	100	0.220	95.0	0.212	91.4	0.213	92.0
10	2.14	94.3	2.02	89.0	1.95	86.0	1.98	87.2	2.02	89.0	2.11	93.0	2.12	93.4	2.03	89.4	1.95	87.2	1.82	80.2	1.76	77.5
31.6	5.97	91.8	5.78	89.0	5.70	88.0	5.72	88.0	5.42	83.4	5.43	82.8	5.02	77.2	4.75	73.1	4.22	64.8	3.79	58.3	3.30	50.8
100	14.85	90.6	14.60	89.0	14.33	87.4	13.75	83.9	12.35	75.3	10.38	63.3	9.72	59.4	8.47	51.6	6.80	41.5	6.22	37.9	5.24	31.9
Wet Gas																						
1	0.156	67.3	0.166	72.0	0.099	42.7	0.137	59.0	0.123	53.0	0.203	87.5	0.207	89.2	0.192	82.8	0.189	81.3	0.145	62.5	0.133	57.8
10	1.30	57.3	1.48	65.0	0.68	30.0	1.07	47.2	0.95	41.8	1.83	80.6	1.79	78.8	1.6	70.4	1.55	68.3	1.14	50.2	0.81	35.9
31.6	2.65	40.8	4.07	62.5	1.77	27.3	2.90	44.6	2.01	30.9	4.42	68.0	4.05	62.3	3.37	51.8	3.20	49.2	2.20	34.5	1.80	27.7
100	5.98	36.4	9.35	57.0	4.9	29.8	6.93	42.3	2.39	14.6	7.80	47.5	6.78	41.3	6.82	41.6	5.73	34.9	4.25	25.9	3.3	20.0

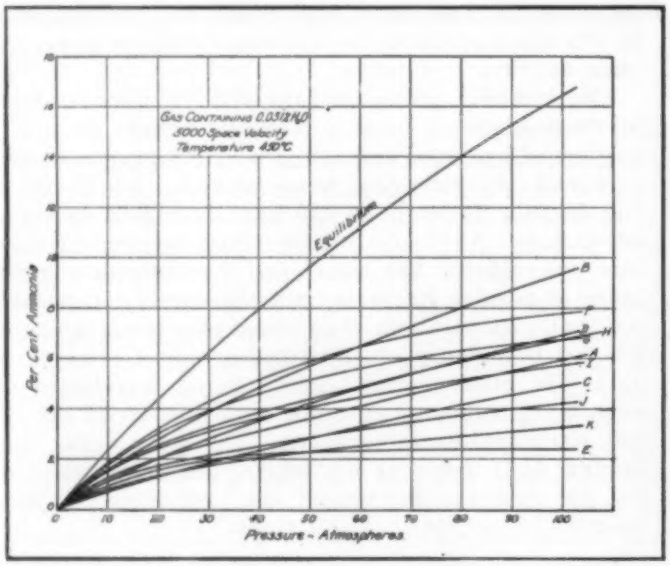

FIG. 2—EFFECT OF PRESSURE ON PER CENT OF AMMONIA USING POISONED GAS

percentage of ammonia produced (per cent NH_3) and also the efficiency (per cent Eff.) that is, the ratio of the actual percentage of ammonia in the gas to that theoretically possible under the conditions in question. Since all these catalysts would be very nearly 100 per cent efficient at 500 deg. C., a lower temperature—namely, 450 deg. C.—was selected, where the real differences in activity are more apparent. The space velocity was 5,000—that is, 5,000 liters of gas were passing over the catalyst per liter of catalyst per hour.

In representing graphically the results of Table I, we have plotted the change in the percentage of ammonia as the pressure is changed and also the variation in efficiency as the pressure is changed. The latter method of expression is the more convenient basis on which to consider the behavior of a catalyst at different pressures, so we shall limit our discussion to Figs. 3 and 4.

In Fig. 3 it will be noted that all the catalysts at 1 atmosphere pressure have an efficiency in excess of 80 per cent. At 100 atmospheres only four are able to maintain that high value. It will also be noted that at 1 atmosphere the catalysts *B*, *C* and *D* show the lowest efficiencies of the group, yet at 100 atmospheres they, together with catalyst *A*, are the only ones which maintain an efficiency of 80 per cent or better. It is evident therefore that one cannot predict from the results on dry gas at 1 atmosphere what the efficiency will be at higher pressures.

Relation of Efficiencies at Different Pressures

All the results which we have accumulated indicate that a catalyst does not increase in activity as the pres-

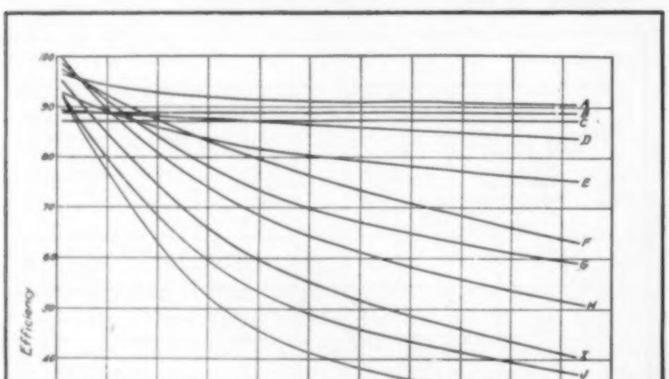

FIG. 3—EFFECT OF PRESSURE ON EFFICIENCY OF CONVERSION USING PURE GAS

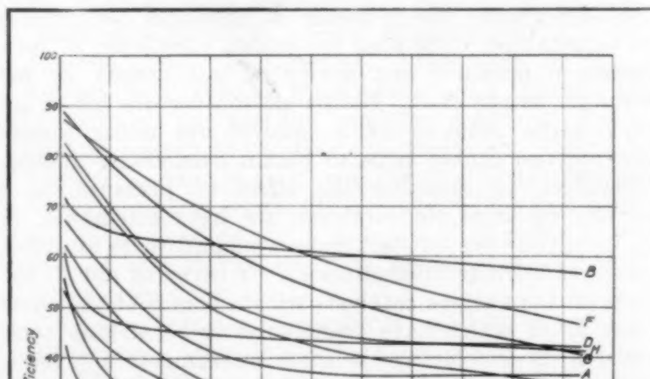

FIG. 4—EFFECT OF PRESSURE ON EFFICIENCY OF CONVERSION USING POISONED GAS

sure is increased. This was probably to be expected and needed only experimental confirmation. It is not, however, so easy to understand why a catalyst like *C*, for example, which is only about 87 per cent efficient at 1 atmosphere, should retain practically that same efficiency at pressures up to 100 atmospheres. We might expect that at 1 atmosphere it would be more efficient than those catalysts which show such a rapid loss in efficiency with increase in pressure. In presenting experiments dealing with the mechanism of the synthetic ammonia reaction, we hope at a later date to discuss more fully these peculiarities. For our present purpose it is sufficient to recognize that efficiency tests at a low pressure are not a safe basis for predicting the behavior of catalysts at a higher pressure.

If, however, the efficiencies at two pressures are known, say at 10 and 30 atmospheres, or better still at 30 and 50 atmospheres, from the general trend of these efficiency curves a very close estimate can be made of the efficiency at some higher pressure, as for example 100 atmospheres. A very large number of our catalysts have been examined in this way and the results have in general been found to be trustworthy.

Effects of Catalyst Poisons

When a catalyst is tested with a gas containing a contact poison, as for example water vapor, we find the same characteristic behavior as has been noted above. Fig. 4 shows the change in efficiency with change in pressure when operating on a gas containing 0.031 per cent water. As would be expected, all the efficiencies have dropped, although in changing from dry to wet gas the order has been somewhat altered. Thus, catalysts which show the highest efficiency on dry gas no longer rank first when tested against wet gas. These results indicate very clearly the importance of making tests with a gaseous mixture of known composition. If the character of the gas is not kept the same in all the tests, the results obtained will not be comparable.

The results in Fig. 4 also emphasize the importance of knowing the behavior of catalysts on impure gas. In technical operation it might not be feasible to produce a gas of such purity as that employed in these "pure gas" tests. Certainly, to make a selection of a catalyst for technical operation from such pure gas tests would not be safe. On wet gas, catalyst *B*, for example, is very much better than catalyst *A* which gave the highest results on pure gas. Of course, it is true that the discrepancy between *B* and *A* would become less as the temperature is raised, but still the optimum temperature when operating on wet gas would certainly be lower in the case of catalyst *B*.

Perpetual Inventory of Stores Discussed in Chamber of Commerce Pamphlet

The Fabricated Production Department of the Chamber of Commerce of the United States has just issued an important pamphlet on perpetual inventory of stores control system as an aid to manufacturing plants. The pamphlet discusses the advantages which accrue from the use of the perpetual inventory. They include a control of the investment in stores to an efficient minimum, the elimination of duplication in types of supplies and the automatic ordering of supplies which need replenishing. This question is timely and will receive much fuller treatment in these pages shortly.

Resale Price-Fixing Scheme Declared Unfair by Supreme Court

By Wellington Gustin
Of the Chicago Bar

UNFAIR competition in trade and commerce is the special concern of the Federal Trade Commission. Its acts and rulings are reviewable by the United States Supreme Court. Unfair dealing in industry is not defined in the act, and decisions of the commission and federal courts are left to determine what constitutes this offense. So a decision of the Supreme Court upholding or reversing a decree of the Trade Commission is of momentous importance to commerce and industry.

The Colgate & Co. case and the Schrader's Son, Inc., case have become historic in industry, and now comes a decision of the U. S. Supreme Court in the case of the Federal Trade Commission vs. Beech-Nut Packing Co. The decision is arrived at through a divided court, five judges to four.

How the resale price of a product may be controlled and forced to be kept up to a specified or determined figure has been the concern of many manufacturers and distributors of various kinds in practically every field of industry. Few have been able to devise a scheme or plan that will stand a test in courts. And one that has been tested out and found to be not in conflict with the Sherman anti-trust law, the Clayton act and the scrutinizing eye of the Federal Trade Commission must be accorded as being ingenious indeed.

Therefore the Supreme Court's recent decision in the Beech-Nut case is of special moment. The Federal Trade Commission had condemned the plan of resale of the Beech-Nut Co. on its products being sold throughout the United States and ordered the company to desist from the alleged illegal practices.

Charges Against the Company

It was charged that the company had adopted and enforced a system of fixing and maintaining certain specified standard prices at which its products shall be resold by purchasers thereof, including jobbers, wholesalers and retailers, with the purpose and effect of securing the trade of such distributors and of enlisting their active support and co-operation in enlarging the sale of its goods, to the prejudice of its competitors who do not require and enforce the maintenance of resale prices for their products; and with the purpose and effect of eliminating competition in prices among all jobbers, wholesalers and retailers, respectively, engaged in handling the company's products, thereby depriving such distributors of their right to sell, and preventing them from selling its products at such prices as they may deem to be, and as are, adequate and warranted by their respective selling cost and efficiency, and with various other effects; and that the company as a means of making effective its system of resale prices and of inducing and compelling its customers and the dealer customers of its customers to maintain such resale prices has:

Made it known generally to jobbers, wholesalers and retailers, respectively, that it required and insisted that they should sell its products at the resale prices so fixed by it, and refused to sell to jobbers, wholesalers or retailers not maintaining such prices; that the company threatened and refused to sell to all jobbers, wholesalers and retailers who failed to maintain the

resale prices so fixed by it, or who sold to other distributors who so failed; that the company caused the diversion of retailers' orders away from jobbers and wholesalers who did not maintain the resale prices so fixed by it, and refused to supply other jobbers, wholesalers and retailers failing to maintain such prices; that the company solicited and secured the co-operation of wholesalers, jobbers and retailers in reporting price cutters, all in pursuance of its efforts to ascertain the names of all distributors of its products who had failed to maintain the resale prices or who had sold to other jobbers and others failing to maintain the fixed prices; that it entered in card records kept by it the names of all dealers reported to it, either in this or other ways, as not maintaining its resale prices or as selling to those who in turn did not maintain such prices, and had taken various measures to prevent all such dealers from obtaining further shipments of its products from any source until it had received from them declarations, promises, assurances, statements or other similar expressions to the effect that in the future such dealers intend to and will sell such products at the resale prices fixed by the company and will refrain from selling to others who fail to maintain such prices; that the company employed various other means and methods for the enforcement of its system of maintaining resale prices.

Charges Found True by Commission

The commission found that the charges were substantially true; that the company selected its wholesale and retail dealers as desirable customers because they are believed to be of good credit standing, willing to resell at the fixed prices and maintain same. Such are designated by the company as "selected" or "desirable" dealers, and include the greater number of such dealers throughout the United States.

The Beech-Nut Policy

The company has adopted and maintained what is known as the "Beech-Nut policy" and requests the co-operation of all dealers selling its products, but dealing with each customer separately. In order to secure such co-operation and to further the policy the company acts as follows:

1. Issues circulars, price lists and letters to the trade generally showing suggested uniform resale prices, both wholesale and retail, to be charged for its products.

2. Requests and insists that the selected jobbers, wholesalers and retailers sell only to such other jobbers, wholesalers and retailers as have been and are willing to resell at the prices so suggested by the company, and requests that they desist from selling to others who fail to resell at the fixed resale prices.

3. Makes it known broadcast to such selected jobbers, etc., whether sold by them direct or not, that if they, or any of them, fail to sell at the resale prices suggested by the company, it will absolutely refuse to sell further products to them.

How It Carries Out the Policy

In carrying out this policy the company refuses to sell to any of the classes who fail to maintain the fixed resale prices in every particular. And it refuses to sell the so-called mail order houses engaged in interstate commerce on the ground that these firms frequently sell to others who resell to such mail order houses. It refuses to sell all so-called price-cutters. It maintains a large sales force of specialty men who call upon the retail trade and solicit orders therefrom to be filled through jobbers and wholesalers; but its salesmen are instructed to and do refuse to accept any such "turnover" orders to be filled through jobbers or others who themselves sell or have sold at less than the suggested resale prices, and in such cases the salesmen request the retailer to name other jobbers.

How Violators of the Policy Are Detected

The company has utilized a system of key numbers or symbols stamped or marked upon the cases containing its products, thus enabling it, for any purpose whatsoever, to ascertain the identity of the distributors from whom such products were purchased. And when instances of price-cutting have been reported the company investigates through its salesmen and representatives, who are able to trace the price-cutters from whom the goods were obtained as well as the distributors from whom price-cutters have purchased the products; and thereafter the company has refused to supply all such dealers with its products.

Blacklisting Violators or Undesirable Customers

Further, the company maintains card records containing the names of thousands of jobbing, wholesale and retail distributors, and in furtherance of its refusal to sell to price-cutters has listed upon these cards, bearing the names of such distributors who do not maintain the fixed prices, the words "Undesirable—Price-Cutters," "Do not sell" or D.N.S., or expressions of like character to indicate that such distributors were not to be sold its goods in the future for failure to maintain the fixed prices, or selling to others who so failed. And when a jobber or other has been entered in the card records as one to whom shipments should not go forward, the company notifies those jobbers, wholesalers, etc., who supply the distributor, of this fact, and also notifies its specialty salesmen, and gives similar notices to such jobbers, wholesalers and retailers and to its specialty salesmen when reinstatements are made in its list of "selected" jobbers, wholesalers and retailers.

What the Circuit Court of Appeals Found

In passing on this case the federal Circuit Court of Appeals was of the opinion that the only difference between the price-fixing policy condemned as unlawful by the Supreme Court in Miles Medical Co. vs. Park & Sons Co. (31 Sup. Ct., 376), and the price-fixing plan embodied in the Beech-Nut policy was that in the former case there was an agreement in writing, while in this case the success or failure of the plan depended upon a tacit understanding with purchasers and prospective purchasers. It believed there was no difference between a written agreement and a tacit understanding in their effect upon the restraint of trade, yet it regarded the case as governed by the decision in United States against Colgate & Co. (39 Sup. Ct., 465), and accordingly held that the commission had exceeded its powers in making the order appealed from by the Beech-Nut Co.

Acts Analyzed and Distinguished in Cases

In the Colgate & Co. case the indictment charged a violation of the Sherman act prohibiting monopolies, contracts, combinations and conspiracies in restraint

of interstate commerce. But on the facts showing what the company had done in maintaining the resale prices of its products the Supreme Court held that such had amounted only to the exercise of the right of the trader or manufacturer, engaged in private business, to exercise his own discretion as to those with whom he would deal and to announce the circumstances under which he would refuse to sell; and that this was one's undoubted right and no crime had been committed.

In a subsequent case to Colgate, in United States vs. Schrader's Son, Inc. (252 U. S., 85), the manufacturer was charged with having sold to manufacturers in several states under an agreement to observe certain resale prices fixed by the vendor. The Colgate case was cited as upholding this company's right so to agree but in distinguishing the two cases and holding the manufacturer in the latter case guilty, the court pointed out that the indictment in the Colgate case failed to charge that the company made agreements, either express or implied, which undertook to obligate the buyers to observe specified or fixed resale prices. The doctrine established in the Miles Medical case, that it was unlawful under the Sherman act to attempt to destroy the dealers' independent discretion through restrictive agreements, is not in conflict with the undoubted right of a manufacturer to specify resale prices and refuse to deal with anyone who failed to maintain the same, as recognized in the Colgate case.

The Supreme Court Announces the Law as Established

These decisions have settled the law in this country that in prosecutions under the Sherman act a trader is not guilty of its violation who simply refuses to sell to others, and he may withhold his goods from those who will not sell them at the prices which he fixes for their resale. He may not, consistently with the act, go beyond the exercise of this right, and by contracts or combinations, express or implied, unduly hinder or obstruct the free and natural flow of commerce in the channels of interstate trade.

The Unfair Methods of Competition

The above-stated doctrine is applied in the Beech-Nut case only in so far as it shows a public policy to be considered in determining what are unfair methods of competition, which the Federal Trade Commission is empowered to condemn and suppress. The Federal Trade Commission act was intended to supplement the Sherman and Clayton anti-trust legislation, and the Beech-Nut suit was begun under it. The commission is given authority after a hearing to make orders to compel the discontinuance by an individual, firm or company of any "unfair methods of competition."

What are "unfair methods of competition" Congress has thought best to leave without precise definition, and to have each case determined upon its own facts, owing to the multifarious means by which it is sought to effectuate such schemes. Subject to judicial review of its decrees and orders the commission has the determination of all such schemes and practices. But it is for the courts, not the commission, ultimately to determine as matter of law what the phrase includes. In another case (253 U. S., 421) it is said by the Supreme Court that the words "unfair methods of competition" are clearly inapplicable to practices never heretofore regarded as opposed to good morals because characterized by deception, bad faith, fraud or oppression, or as against public policy because of their dangerous tendency unduly to hinder competition or create monopoly. The act was certainly not intended to fetter free and fair competition as commonly understood and practiced by honorable opponents in trade, the court says.

The declaration of public policy under the Sherman act permits a trader to refuse to sell goods to persons who will not sell at stated prices. But in the recent Beech-Nut case the system of merchandising was found to go far beyond this, being against public policy because of "its dangerous tendency unduly to hinder competition or to create monopoly." This "dangerous tendency" is another indefinite phrase, if not a "dangerous" one. The decision is by a majority of the court, five to four.

The opinion states that the Beech-Nut system of merchandising constitutes a scheme which restrains the natural flow of interstate trade which it has been the purpose of all the anti-trust acts to maintain. It says that in its practical operation it necessarily constrains the trader, if he would have the products of the Beech-Nut Co., to maintain the prices "suggested" by it. If he fails to do so, he is subject to be reported to the company either by special agents, numerous and active in that behalf, or by dealers whose aid is enlisted in maintaining the system and the prices fixed by it. Furthermore he is listed as "Undesirable—Price Cutters," to whom goods are not to be sold, etc. From this course of conduct the court concludes that competition among retail distributors is practically suppressed, for all who would deal in the company's products are constrained to sell at the suggested prices. Nor is this conclusion overcome by the fact that the merchandising conduct of the company does not constitute a contract whereby resale prices are fixed, maintained or enforced. The specific facts found show suppression of the freedom of competition by methods in which the company secures the co-operation of its distributors and customers, which are quite as effectual as agreements express or implied intended to accomplish the same purpose. By these methods the company, although selling its products at prices satisfactory to it, is enabled to prevent competition in their subsequent disposition by preventing all who do not sell at resale prices fixed by it from obtaining its goods. The authority and power of the Trade Commission to order a discontinuance of such trade practices is undoubted.

Forest Products Laboratory Publishes Decennial Record

A complete report of the proceedings of the decennial celebration held at the Forest Products Laboratory in July, 1920 (see CHEM. & MET. ENG., vol. 23, p. 270, Aug. 18, 1920), forms part of an attractively printed and handsomely bound volume which has just been published by the Decennial Committee under the chairmanship of Howard F. Weiss.

The first part of the book traces the origin of the Forest Products Laboratory and then treats of its growth, organization, equipment, personnel, its pre-war research, war work and plans for future research. There are also chapters on the financial value of research results and on how to use the laboratory.

Copies of this valuable record of the work of the Forest Products Laboratory may be obtained from the Director for $1.75.

Executives of the Future

BY J. J. LAWTON

ONE of the most serious problems with which the factory executive always has to deal, in bad times as well as in good, is that of finding capable assistants. How little does the typical executive realize this fact! If times are good he wants men on whom he can depend to get a maximum yield from the plant. In bad times he needs men who will keep the cost of production down to a minimum.

The policy of the average manufacturing plant of today is to drop competent men when production lags for want of a market, and then to import executives when the need arises. That is, they obtain men from outside the organization to fill positions that rightly belong to those who have helped build it up. Such importations are likely to play havoc with the morale of the staff, which usually includes a few who have forged their way along by sheer persistence and force of character. However, it may be said that in general these men lack the breadth of view and general grasp of the scope of the business as a whole that would render them efficient executives. Of course there are exceptions: men who in sticking to their jobs have had the intelligence to learn the scientific principles underlying the development of the industry, but these are rare. Many reach their saturation point of efficiency long before they gain the top. After that their competency dwindles steadily as they ascend.

EXECUTIVES NEED A COURSE TO FIT THEM TO TRAIN OTHERS

Modern business lays great stress on the training and education a young man should have before he is graduated into the school of commerce. When these young men do not come up to the mark in industry it is customary to blame the colleges and universities for their defective curriculum, or for turning out a poor class of graduates. Instead of this, however, the fault should be laid at the door of our modern executives, so called. It is they who are in need of a thorough course of training in industrial pedagogy which would fit them to train others in turn—to develop young material into competent assistants who ultimately will become successors to themselves. In this case the benefits of experience would manifest themselves and many plants would not be standing still, as they are today.

A young man, after leaving college, enters some corporation or plant. In most cases he is started at the foot of the ladder, in the "submarginal" class. And there, as a rule, he stays. True, there are companies with the vision and practical good sense to train their young men to become "supermarginal" in their respective lines, but these are the exception. In general the young chemist or engineer receives from his superiors no help which would enable him to climb, the usual policy being to keep him on any routine work in which he has shown himself to be proficient.

It is our engineers and chemists who should control production and manage our industries, and not our corporation lawyers and bankers with lucrative salaries who, with a stroke of the pen, can stop all research work, thus thwarting progress and throwing thousands of chemists and engineers out of employment. It is only a matter of time when these conditions must be changed. In order to compete with European industries, research work must go on, unhampered. Otherwise our chemical industries will disappear, and only a few monopolies will remain.

Ours is still to some extent a new country. Its opportunities have been so varied and numerous that ability in the rough has been sufficient to make good. But the day of untutored success in business is passing. The untrained man has less and less chance daily in obtaining the best places. The rough diamond who molded raw new-country conditions with inborn shrewdness is giving way to the smooth, well-read man, who trains his future executives so that they, in turn, will carry on the policy of wisdom with the men under them. Organized training on the part of our executives will develop the breadth of vision, the fertility of resource, demanded by latter-day business. In a word, a general realization of the need of wider perception and finer initiative on the part of our executives is bound to produce admirable results in industry. And it is a matter of vital importance to the stockholders—in the long run.

The Early Bird Certainly Gets the Worm in the Oil Fields

A very interesting report which will shortly be published by the U. S. Bureau of Mines states that delay in drilling property in a field that is being worked often results in a loss of 50 per cent of the possible production of a well. The report is based on studies by one of the engineers of the bureau in the Oklahoma, Louisiana and California fields. Many examples are given where a delay in the time of drilling was responsible for a loss of several thousand barrels per acre. Two wells exactly similar in every respect except that one was drilled nearly a year later than the other showed a difference of 53 per cent production per acre. This was in the Adair pool in Oklahoma. It has now become an axiom of the oil fields that a man must drill or be prepared to accept his loss with good grace.

An interesting analogy exists between the game laws of England and the oil fields. A deer may run across many pieces of property, but it finally belongs to the man on whose property it is killed. So it is in the oil fields. There is no way of storing oil under ground and you may have oil under your property, but it will come up through your neighbor's well unless you have one too.

Methods of Extinguishing Zinc Dust Fires Studied by the Bureau of Mines

Serial Report 2,335, issued last month by the Bureau of Mines, deals with the subject of zinc dust fires. Piles of zinc dust which are burning offer many difficulties. Water or other liquids when thrown on such a pile explode and scatter the burning powder. In addition, water will decompose, giving its oxygen to the zinc and setting free hydrogen, which of course aids the combustion.

In all, five extinguishers were used—water, sodium carbonate solution, carbon tetrachloride, silicon tetrachloride and a frothy mixture. The frothy mixture extinguished the fire most quietly and effectively. A large fire was then tested with the foam extinguisher. The fire was smothered effectively, but the pile retained its heat for several hours, so that the foam had to be left in place for some time to avoid rekindling. This objection would be more and more serious as the size of the pile increased, but the frothy mixture proved easily the best of the extinguishers tested.

New Aluminum Alloys of High Strength

Digest of Eleventh Alloys Research Report to the Institution of Mechanical Engineers—Important Properties of "A" Alloy (77:20:3 Al:Zn:Cu)—Another Alloy Has an Ultimate Strength of 91,000 Lb. Per Sq.In. With 9 Per Cent Elongation

THE tenth of a notable series of reports to the Alloys Research Committee, British Institution of Mechanical Engineers, was published about 8 years ago. Since that time the investigation of the light alloys of aluminum has been greatly expanded and increased in scope. The original plans contemplated a systematic investigation of the whole field of aluminum alloys, and the eighth, ninth and tenth reports dealt with the aluminum-copper, aluminum-copper-manganese alloys, and the aluminum-zinc alloys respectively. The war emergency, however, made the development of light alloys a national necessity. Previous experience of the members and investigators of the committee, in part unpublished, furnished an excellent foundation for the extensive investigation of the most promising aluminum alloys, an inquiry which was undertaken at once. Publication has now been made of the eleventh report, prepared by Messrs. Rosenhain, Archbutt and Hanson in collaboration with other members of the staff of the National Physical Laboratory at Teddington, England, and with the co-operation of a number of English industrial concerns and other laboratories engaged in the study of aluminum alloys for war purposes.

The eleventh report, from which these notes on new alloys have been taken, contains 256 pages of text and includes 171 figures. The authors confess at the outset that the wealth of data at their disposal and the demands of conciseness permit only a very sketchy treatment of the subject. It includes, therefore, only the more important phases of the investigation, and with only sufficient detail to give a clear understanding of the results and conclusions reached.

Cast Alloys

Twenty of the ternary alloys containing up to 4 per cent copper and 30 per cent zinc similar to those described in the tenth report were studied in the form of both sand and chill castings. The tensile strength was found to increase with increasing content of zinc, but variation of the copper content from 1 to 3 per cent made no substantial difference. With 15 per cent zinc the strength in sand castings was of the order of 30,000 lb. per sq.in.; tensile strengths as high as 44,000 lb. per sq.in. were obtained by increasing the zinc content to about 30 per cent. There are, however, certain inherent defects in these alloys from the commercial standpoint. High strength produced by a high zinc content (25 per cent) is accompanied by a relatively high density (3.2 as compared with 2.7 for pure aluminum), the alloys are hot-short, and the elongation is low. Fifteen per cent of zinc seemed to be about the practical limit, and a commonly used specification known as "L5" called for 12.5 to 14.5 per cent of zinc and from 2.5 to 3 per cent of copper.

[1]By the Institution of Mechanical Engineers, Storey's Gate, St. James' Park, London, S. W. Price, £2 2s.

These zinc alloys showed the phenomenon of aging to a marked degree. On standing at room temperature there is a substantial increase in the strength, amounting to about 30 per cent in the course of 7 to 9 months; this gain in strength is accompanied by a decrease in elongation. However, the marked loss in strength of these alloys at elevated temperatures, together with other properties, indicates a limited field of usefulness.

Alloys for Use at High Temperatures

As just indicated, the zinc alloys show a serious loss in strength as their temperature is raised. The importance of the use of aluminum alloys as pistons of airplane engines and automobiles and in other places where they are subjected to elevated temperatures made it essential to find alloys suitable for such duty. Considerable effort was spent on this problem. As a step in this investigation the strength of cast aluminum-copper alloys containing 6, 8, 12 and 14 per cent copper was investigated at temperatures up to 350 deg. C. At a temperature of about 200 deg. C. there was no significant difference in the strength of all four alloys as chill-cast. At the higher temperatures, of 300 and 350 deg. C., there is a marked advantage in favor of the alloys containing 12 and 14 per cent copper. The 92:8 Al:Cu alloy, chill-cast, changed in strength from about 18,400 lb. per sq.in. at 20 deg. C. to 7,500 lb. per sq.in. at 350 deg. C. Similarly the 86:14 aluminum-copper alloy had a strength of about 22,000 lb. per sq.in. at 20 deg. C., and 10,700 lb. per sq.in. at 350 deg. C.

It was found that manganese was a valuable addition in increasing the strength of aluminum alloys at high temperatures. The maximum improvement was secured with 1 per cent manganese. Aluminum-copper-manganese alloys containing 1 per cent manganese were actually stronger at 250 deg. C. than at room temperature; the increase amounted to about 2,000 to 2,500 lb. per sq.in. Above 250 deg. C. the strength fell off at the same rate as with the Al:Cu alloys without manganese. There was some practical difficulty in the use of the 85:14:1 Al:Cu:Mn alloy in the foundry, so other alloys containing iron, molybdenum, tungsten, chromium or vanadium were investigated. None of these alloys proved entirely satisfactory.

The effect of nickel was then investigated and it led to results of first importance. One to 3 per cent Ni was tried in combination with from 8 to 12 per cent Cu. It exerted a beneficial effect, but there was still a marked decrease in strength at moderate temperatures. Magnesium was then added in addition to copper and nickel, whereupon a marked improvement was obtained. Investigation of the limits of the three components showed the 4 copper, 2 nickel, 1.5 magnesium alloy (remainder aluminum) to be the best combination, and this alloy, known as "Y" alloy, was

made the subject of an extensive investigation. It was also found suitable for forging and rolling. The preparation, treatment and properties of "Y" alloy will form the subject of another article in this journal, as its importance seems to warrant separate treatment.

Casting Contraction

The total linear contraction on casting was determined for a number of alloys. As shown in Fig. 1, the method consisted of casting a ½ x 1-in. bar 10 in. long in a steel yoke, and after cooling measuring the contraction. The highest contraction was noted in the

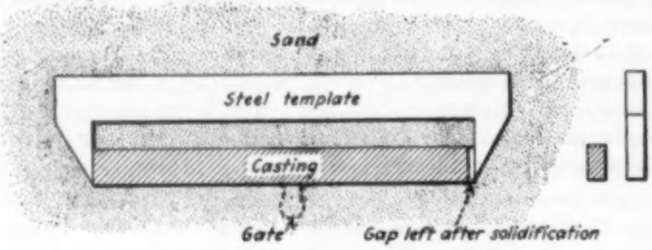

FIG. 1—METHOD FOR DETERMINING LINEAR CONTRACTION

binary alloy with 15 per cent zinc and amounted to 1.42 per cent. The 85:14:1 Al:Cu:Mn alloy was among the lowest, with a contraction of 1.21 per cent. No differences in the solid shrinkage were observed which could account for the marked differences observed in casting the different alloys.

Thermal Conductivity

One marked advantage which the aluminum piston offers lies in the high thermal conductivity of the metal. It is important, therefore, that the alloy selected be favorable from this standpoint also.

A series of determinations of the thermal conductivity of certain of the aluminum alloys was carried out by Dr. E. H. Griffiths of the heat department of the National Physical Laboratory. As far as is known to the abstractor, these are the only thermal conductivity data available on aluminum alloys, and a few are reprinted in Table I. The full report contains information

TABLE I—THERMAL CONDUCTIVITY OF SOME ALUMINUM ALLOYS

Chill Cast Specimens

		Thermal Conductivity, C.G.S. Units			
		As Cast		Annealed at 450 Deg. C.	
Name	Analysis	100°	300°	100°	300°
	Pure aluminum	0.52	0.52	.....	.....
"L5"	Al + 2.75 Cu + 13.5 Zn	0.31	0.37	0.34	0.35
	Al + 7.91 Cu + 0.82 Fe	0.35	0.38	0.40	0.42
	Al + 8.18 Cu + 2.09 Fe	0.34	0.36	0.38	0.39
	Al + 13.9 Cu + 0.98 Mn	0.27	0.30	0.37	0.38
	Al + 8.0 Cu + 0.98 Mn	0.25	0.30	0.36	0.39
"Y"	Al + 4 Cu + 2 Ni + 1.5 Mg	0.37	0.40	0.40	0.41
Gray Cast Iron	3.5 C + 1.8 Si + 0.08 S + 1.1 P + 0.8 Mn	0.102	0.099	0.121	0.113

on both sand and chill castings, but the data are complete only for chill castings and since there was no significant difference the values for the latter are taken for comparison.

Heat-Treatment of Castings

Although the opinion was commonly held that castings of the composition of duralumin (4 Cu, 0.5 Mn, 0.8 Mg, 0.5 Si, remainder Al) could not be materially improved by heat-treatment, nevertheless the authors satisfied themselves that by the selection of the proper conditions a very desirable improvement could be obtained. Their tests showed that in chill-cast test-bars containing up to 4 per cent of copper all of the $CuAl_2$ could be brought into solid solution by 3 days' heating at a temperature between 450 and 520 deg. C. Only a trace of undissolved $CuAl_2$ remained in a sample containing 4.5 per cent copper. Such annealing increased the strength of the 4.5 per cent copper alloy from 21,100 to 33,600 lb. per sq.in. It is not stated whether the sample was quenched or not after heating. It was also found that temperatures as high as 530 deg. C. could be successfully used for heat-treating copper-aluminum castings. Alloy "Y" proved exceptionally amenable to heat-treatment.

Wrought Alloys

In investigating the working of aluminum alloys by forging, rolling, extrusion and drawing, the first series investigated was the ternary system Al: Zn: Cu. Alloys containing up to 25 per cent zinc and 4 per cent copper were cast in cylindrical billets, 3 in. in diameter and 19 in. long. It was first attempted to roll these experimental billets at a plant of the British Aluminium Co., but difficulty was experienced because the regular practice was not suitable for rolling such hard alloys. Steps were taken, therefore, to install an experimental mill at the National Physical Laboratory.[3] The chief difficulty encountered was the cracking of the ingots during the hot-rolling, and surface defects and edge cracking in the finished sheet. Information gained in preliminary rollings, however, indicated that the 3 copper-20 zinc alloy was about the most promising of the lot and its properties were sufficiently good to warrant further investigation.

Development of Alloy "A" or "3/20"

First it was attempted to roll the alloy containing 3 per cent copper and 25 per cent zinc into bars and rods. About fifty of the 3-in. billets were tried with preliminary forging of various degrees, with working temperatures from 400 deg. C. down to 300 deg. C., and with variations in the rolling speed and reduction per pass without eliminating the serious cracking. Although the authors believe that the "3/25" alloy could have been rolled satisfactorily after a sufficient study of the problem, the urgent need for light alloys caused them to center their efforts on the somewhat softer "3/20" alloy, which has been christened "A." Between June, 1915, and March, 1916, they demonstrated to their satisfaction that this alloy could be satisfactorily produced. As a result of their extended experiments they concluded that most of the cracks and defects developed on rolling could be traced back to the original ingot and only when proper attention was given to the casting of the ingot could a satisfactory product be assured. Slow pouring of billets was adopted, with the mold tilted at an angle of about 45 deg. The object in pouring slowly was to permit solidification of the metal in the mold to proceed at about the same rate as the liquid metal was added. Thus shrinkage cavities were largely avoided and little or no "heading up" of the ingot was required. Molds were also used at a relatively low temperature (100 deg. C.).

In addition to the necessity of careful control of the casting of the ingots, the authors found it necessary to give "A" ingots a forging treatment. Hot-forging at 400 deg. C. was followed by an intermediate annealing

[3]To be described in some detail in the subsequent article on "Y" alloy.

and another forging operation together with a final annealing for 1 hour at 450 deg. C. before rolling. The object of the annealing was to obtain complete absorption of the free $CuAl_2$ and a more homogeneous structure. It is also necessary to lubricate the rolls properly. When it was attempted to cast and roll slabs 7 x 14 x 1½ in., more difficulties were encountered. Cracking and surface defects were quite common. The fact that they could be largely eliminated by machining the surface of the ingot to a depth of about ⅛ in. before rolling demonstrated again that the cast surface of the ingot was the source of part of their difficulties, and this trouble was largely overcome by careful attention to detail.

Extrusion

In view of the early troubles in breaking down chill-cast ingots, extrusion was resorted to in order to get the metal in shape for subsequent rolling. Many of the hard alloys were successfully extruded at temperatures much lower, but requiring higher pressures than for aluminum. Longitudinal central defects leading to lamination in the extruded bars have injured the reputation of extruded bars. These defects are due to original contraction cavities in the ingot, or by drawing down portions of the skin into the bar. Such troubles were therefore eliminated by correct pouring practice—as noted above. Drawing of the rear surface of the ingot into the center of the bar can be avoided by placing a corrugated friction plate of steel between ram and billet. Alloy "A," for instance, when successfully extruded in bars 1½ in. in diameter and greater, gives tensile properties closely analogous to those of the same alloy after forging and rolling.

Overannealing

In cold-working, such as spinning of this alloy sheet, it was found that 250 deg. C. was the most satisfactory annealing temperature, as it gave the highest ductility to the annealed product. Thirty minutes' annealing at 100 deg. C. produced a noticeable softening of alloy "A" sheet, while annealing at 180 deg. C. produced the maximum softening and gave material having a tensile strength of 42,000 lb. per sq.in. and an elongation of 29 per cent in 2 in.

Experiments on the behavior of the alloys under prolonged stress led to the discovery that many of them can be seriously damaged by annealing at moderate temperatures. This type of fracture occurs between the crystals, and is very similar to "season cracking." It may be investigated by bending a strip of comparatively thin sheet into a U with about 1½ in. radius, when it acquires a permanent set. If a piece will withstand this position for several days it never undergoes failure in use—at least for 2 or 3 years.

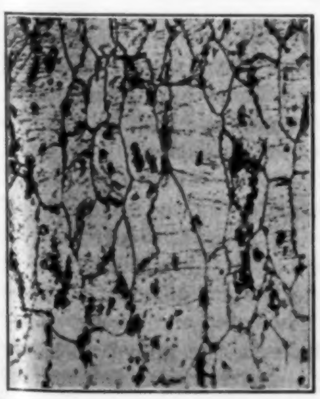

FIG. 2 (AT LEFT)—HOT-ROLLED ALLOY "A"
Annealed at 250 deg. C. Immune from intercrystalline cracking. × 125.

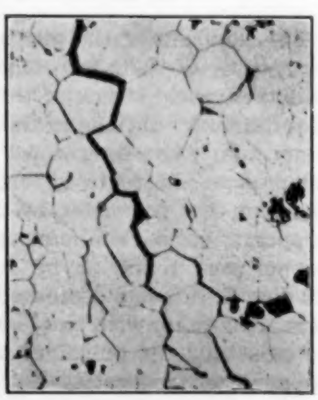

FIG. 3 (AT RIGHT)—ALLOY "A"
Intercrystalline crack in overannealed structure. × 125.

Hot-rolled "A" alloy is entirely free of intercrystalline fracture induced by bending, if the reduction after any possible heating is 50 per cent. Such safe materials having a structure shown in Fig. 2, however, if annealed 1 hour at more than 250 deg. C., will fail in short time—the quicker the higher the anneal. High annealing produces an equiaxed structure shown in Fig. 3. Heat-treatment has so far been found inadequate to correct this liability for fracture. A low amount of "overannealing" can be cured by a moderate amount of cold-work; an excessively overannealed piece can be rendered immune from failure under the bend test only by a reduction while hot of at least 50 per cent, applied in moderate drafts.

This alloy in the form of thin sheet was suggested as a covering for airplane wings, and with this object in view the British Aluminium Co. eventually produced sheets 12 in. wide by 6 ft. long and 0.0035 in. thick. This sheet had a tensile strength of 51,000 lb. per sq.in. and an elongation of 3 per cent in 2 in., after annealing at 250 deg. C. Its low resistance to ripping seemed to be a decided disadvantage as a covering for airplane wings.

TABLE II—PHYSICAL PROPERTIES OF ALLOY "A" (77 Al, 3 Cu, 20 Zn)

Density = 3.1

Material	Condition	Yield Point, Lb./Sq. In.	Tensile Strength, Lb./Sq. In.	Elongation, Per Cent in 2 In.
Rod; 1½ in. dia.	Hot-rolled	39,400	59,100	17
Rod; ¾ in. dia.	Hot-rolled	41,000	60,500	21
Sheet; 0.104 to 0.048 in. thick	Hot-rolled	37,900	61,000	19
Sheet; 0.05 in. thick	Hot-rolled and aged 4 years	60,500	74,000	16
Sheet; 0.104 in. thick	Hot-rolled and annealed at 200 deg. C.	27,600	49,800	24-28
Sheet; 0.119 to 0.048 in. thick	Cold-rolled	58,300	66,500	11

Tests of a wide variety were made on the alloy and included compression, fatigue (alternating stress), notched bar impact, at ordinary and at high temperatures. Exposure to temperatures as low as —185 deg. C. had no deleterious effect on the alloy. The properties of this alloy in various forms and after different treatments are summarized by characteristic tests in Table II.

Development of Alloy "E"

Concurrently with the development of alloy "A" the possibility of still further improving it by the addition of magnesium and by heat-treating was investigated. It was found impossible to roll or forge these alloys containing 0.25 to 0.5 per cent magnesium. If the alloy were first extruded, however, it could be readily hot-rolled. Some experimentation led to an alloy having the following nominal composition and known as alloy "E."

	Per Cent		Per Cent
Copper	2.5	Manganese	0.5
Zinc	20.0	Iron (not over)	0.20
Magnesium	0.5	Silicon (not over)	0.20

Tensile tests of this material in the form of a ¾-in. rod showed strengths of over 80,000 lb. per sq.in., with an elongation of 12 per cent in 2 in. These properties merited further development, and the rolling of sheet was investigated.

Again, the cast slabs gave trouble. One improvement

was made by discarding the use of the rich 20 per cent magnesium-aluminum alloy for the addition of magnesium and adding the pure magnesium metal in the form of a couple of sticks just before pouring. Furthermore, it was found necessary to carry out the preliminary forging at a low temperature (300 deg. C.) and to break down the slabs in the rolls at about the same temperature. After a 50 per cent reduction in thickness was effected, a higher rolling temperature (400 deg. C.) was employed. Edge-cracking was always serious with these alloys and the scrap loss high; machining the surface of the ingots had to be done. Typical tests of sheet rolled from this alloy are given in Table III.

TABLE III—PHYSICAL PROPERTIES OF ALLOY "E"—18-GAGE SHEET

Condition	Yield Point, Lb./Sq. In.	Tensile Strength, Lb./Sq. In.	Elongation, Per Cent in 2 In.
As hot-rolled	59,000	70,400	15
As hot-rolled	55,600	73,000	16
Annealed at 250° C	32,500	56,700	20
Quenched from 250° C. and aged	30,700	52,200	22
Quenched from 350° C. and aged	61,200	81,800	10
Quenched from 400° C. and aged	62,300	86,700	9
Quenched from 400° C. and aged	68,400	87,600	11

Although remarkably high tensile strengths were obtained after quenching and aging, the ductility was rather low. By reducing the magnesium content to 0.25 per cent, or by reducing the magnesium to 0.25 per cent and increasing the silicon to 0.5 or 1.0 per cent, the ductility was materially improved with only a small reduction in tensile strength.

The highest strength for any aluminum alloy given in this report was obtained with alloy "E" after extrusion, hot-rolling, quenching from 400 deg. C. and aging. It then had a strength of 91,100 lb. per sq.in. and an elongation of 9 per cent in 2 in. Alloy "E" is a typical duralumin composition except for rather low copper and the addition of 20 per cent zinc.

Both alloys "A" and "E" showed a serious loss in strength at slightly elevated temperatures (150 deg. C., for example), so that alloy "Y," which in castings had proved so satisfactory, was developed as a rolling alloy. Its properties proved to be quite similar to those of alloys of the duralumin type except that alloy "Y" maintained these properties somewhat better at elevated temperatures.

In summarizing and comparing the properties of these alloys the authors put alloys "A" and "Y" in a class by themselves as regards ease of production. They feel, however, that alloy "E" and its modifications possess certain properties which might for certain purposes discount the manufacturing difficulties. The possibility of season cracking with alloy "A" is one which should be considered. All of these alloys except "Y" are quite susceptible to corrosion and would need proper protection. They are also somewhat denser, which is a disadvantage for some purposes.

Permanance of the Alloys

The literature has contained references from time to time concerning the deterioration of certain aluminum alloys on long standing. The fact that the zinc alloys and alloys of the duralumin type undergo an internal change at ordinary temperatures raises the question as to what the ultimate course of these changes might be and what reliance might be placed on the stability of this material. The authors had this point in mind and were able to bring data collected over a period of 10 years as evidence to the reliability of these alloys, and the conclusions are quite reassuring. While the alloys studied (and more particularly duralumin, as it was the oldest of these alloys on which they had made tests) showed certain changes in the direction of increased hardness and strength, the ductility was only slightly diminished and they were sufficiently stable in dimension and length for all practical purposes.

Cast specimens of "L5" (2 to 3 per cent copper and 12 to 15 per cent zinc) showed an increase in tensile strength of about 30 per cent and a decrease in elongation from about 2 to 3 per cent to 1 per cent after a period of 10 months.

Rolled alloys increased in hardness on aging with increase of the zinc content. A 1¼-in. diameter hot-rolled rod (2 per cent copper and 15 per cent zinc), had a Brinell hardness number of about 94 at 7 months after production; 10 years later the hardness had increased to 150. A sample of sheet from alloy "A" (3/20) 0.103 in. in thickness had a strength of 57,500 lb. per sq.in. and an elongation of 14 per cent, as rolled; after 4¾ years its strength was 64,300 lb. per sq.in. and its elongation 10 per cent. The aging was more marked in thin sheet than in thick sheet.

Other alloys were of relatively recent development and results extending back much over a year were not available. Some samples of duralumin manufactured by the regular makers of that alloy and tested in 1911 and again in 1921 showed an increase from 60,500 to 63,200 lb. per sq.in. in strength and a reduction in elongation from around 18 per cent to about 15 per cent. The yield point increased from 38,500 to 46,100 lb. per sq.in. This material is, of course, not typical of present-day production, but the results are nevertheless of value; they indicate no serious deterioration in the properties of the alloy.

Duralumin, as first suggested by Wilm, contained 3 to 4 per cent of copper, about 0.5 per cent of magnesium, and iron and silicon in the proportions contained in the original ingot. The composition is fairly well standardized now on 3.75 per cent copper, 0.5 per cent magnesium, and 0.6 to 0.7 per cent manganese.

Alloys of the duralumin type and "Y" alloy, when heat-treated were the best of the alloys described as regards resistance to corrosion. Alloys "A" and "E" were very seriously corroded by prolonged contact with even weak saline solutions like tap water, and would require adequate protection where exposed to the weather or similar corrosive environments.

Constitution of the Alloys

Development of the alloys described was accompanied by a study of their constitution and microstructure, and this theoretical attack of the problem was indispensable. Equilibrium relations in the ternary system copper-zinc-aluminum were determined in continuation of the plan adopted in the tenth report. Copper-aluminum binary diagram was completed by determining the solubility of copper in solid aluminum; at 540 deg. C. 5 per cent of copper was found to be soluble in aluminum and at 20 deg. C. this had decreased to about 3 per cent. In the ternary system with zinc, no new compounds were found to exist and the principal phase in the alloys with low copper and moderately high zinc is a solid solution of copper, zinc and aluminum.

Although the iron-aluminum system had been investigated by Gwyer, the diagram was not complete at the aluminum end. It had been found that the compound

$FeAl_3$ forms a eutectic with aluminum which contains 2 per cent iron and melts at 648 deg. C. $FeAl_3$ was found to be practically insoluble in solid aluminum, and the purest aluminum they examined still showed the presence of free $FeAl_3$.

Aluminum and silicon form a eutectiferous series with a eutectic at about 10.5 per cent silicon. The authors state that silicon is sparingly soluble in solid aluminum; they were able to bring 1.5 per cent into solid solution, and the solubility did not appear to decrease appreciably as the temperature was lowered. They note that when the silicon alloys are attacked with strong oxidizing agents, as in the chemical analysis of such alloys, part of the silicon resists attack and may be determined as free silicon, while part is oxidized and determined as silica. The part which is oxidized to SiO_2 is supposed to be the silicon which was in solid solution or in combination in the aluminum, while the portion determined as silicon existed as free crystals of silicon in the alloy.

The iron-silicon-aluminum system is important, as iron and silicon occur as impurities in all aluminum made by present-day processes. Alloys containing silicon up to 8 per cent and iron up to 8 per cent have been investigated. Fig. 4 shows a new constituent, identified as constituent "X," but its composition was not determined. The constitution of the ternary alloys containing up to 4 per cent silicon has been established, and is illustrated by a number of diagrams.

An investigation of the aluminum-magnesium diagram by Hanson and Gayler has already been published in the *Journal* of the Institute of Metals. The ternary system silicon-magnesium-aluminum has been investigated up to 11 per cent silicon and 35 per cent magnesium; equilibrium relations are quite complex and the full report must be studied for a complete understanding of the alloys. A compound Mg_2Si was identified as blue crystals of striking appearance. This compound, Mg_2Si, and aluminum form a eutectic freezing slightly below 600 deg. C., as in typical binary systems, and this eutectic contains about 13 per cent Mg_2Si (8.2 per cent magnesium and 4.8 per cent silicon). (See Fig. 5.) At the eutectic temperature about 1.6 per cent Mg_2Si (1.0 per cent magnesium and 0.6 per cent silicon) is soluble. The solubility decreases very appreciably at lower temperatures and at 30 deg. C. not more than 0.54 per cent Mg_2Si is soluble; even this latter figure is probably somewhat high.

Age-Hardening of Alloys of Aluminum With Magnesium and Silicon

The authors establish the fact that when magnesium and silicon are both present in aluminum, the alloy has the property of hardening after quenching. In order to identify the hardening effect with the compound Mg_2Si, a series of specimens was prepared in which the amount of Mg_2Si increased progressively to well beyond the solubility limits of that compound at the eutectic temperature. These samples were first forged and rolled to strips $\frac{1}{16}$ in. thick. After heating 1 hour at 500 deg. C., samples of each were quenched and other samples were slowly cooled in the furnace. After aging for 7 days the samples were tested. The results showed a progressive increase in hardness as the amount of Mg_2Si was increased up to the limit of solubility; thereafter the hardness remained practically constant. Other tests with alloys containing either silicon or magnesium in excess of the ratio to form Mg_2Si were made and confirmed this conclusion. All of the alloys examined reached a maximum hardness in the neighborhood of the solubility line.

These results convinced the authors that the aging of these alloys is due to the fact that the Mg_2Si, by quenching, is retained in an unstable form, such as a solid solution, and that this reverts to a more stable form on standing. Gradual hardening is believed to be the result of the tendency to form particles of Mg_2Si of sub-microscopic size. No visible change is revealed by the microscope. The evidence indicates that the alloys in the quenched and age-hardened condition are permanent—that is, in stable equilibrium—at ordinary temperatures. Their theory of the mechanism of the hardening of duralumin is quite similar to that developed independently by Merica, Waltenberg and Scott at the Bureau of Standards. The American investigators attributed the hardening largely to the compound $CuAl_2$, whereas the authors state that $CuAl_2$ is not able to produce hardening of the order found in the heat-treatment of such alloys, and that the part corresponding somewhat to that played by cementite (Fe_3C) in steel is played by Mg_2Si in these compounds.

Duralumin is completely hardened after about 4 days at room temperature; the greater part of the hardening

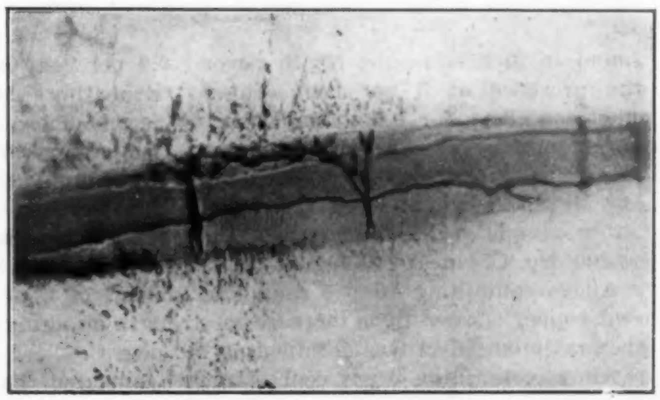

FIG. 4—ALLOY 91:8:1 Al:Fe:Si

Annealed 170 hours at 565 deg. C. Matrix of aluminum-rich solid solution; long crystal of $FeAl_3$ surrounded by an envelope of constituent "X". Etched with 10 per cent NaOH in water. × 1,000.

occurs in the first 24 hours, however. Magnesium-silicon alloys just discussed attain complete hardness in about the same time, except one sample which contained magnesium in excess of that required to form Mg_2Si and which was not completely hardened after 12 days; the final hardness was then lower. This anomaly the authors attribute to the lowering of the solubility of Mg_2Si by the excess magnesium.

High aging temperatures were investigated on these same alloys, which contained silicon from 0.6 to 1.0 per cent and magnesium from 0.6 to 2.0 per cent. Improvement in strength increased with the temperature, and a maximum hardness was reached by heating at 200 deg. C. Higher aging temperatures resulted in rapid decrease in hardness and tensile strength.

The effect of copper, zinc and nickel on the age-hardening of aluminum as effected by the compound Mg_2Si was studied. A series of alloys, each containing 3 per cent of copper and magnesium silicide varying from the minimum corresponding to the silicon content of the alloy up to 3 per cent, was prepared. They were all heated at 500 deg. C.; one sample of each was quenched and a second cooled slowly in the furnace.

They were then tested after aging 3 weeks at room temperature. Age-hardening was quite appreciable with 0.55 per cent Mg_2Si, corresponding to 0.20 silicon. The maximum effect was reached with 0.9 per cent Mg_2Si (0.35 per cent silicon); this amount corresponds to the solubility of Mg_2Si at 500 deg. in aluminum containing 3 per cent copper. They conclude that the addition of copper reduces the amount of Mg_2Si which can be dissolved and hence reduces the maximum hardening effect which it is possible to obtain. No advantage was

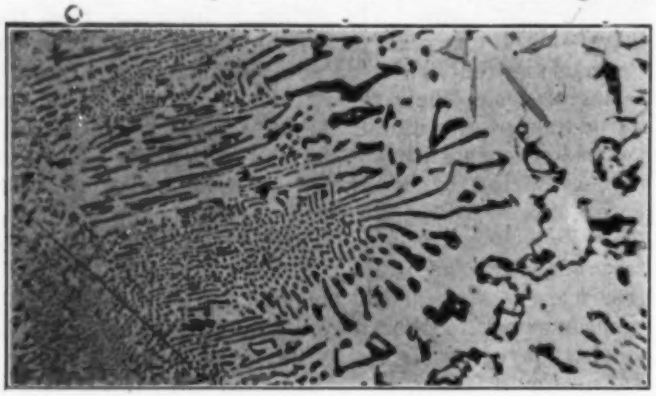

FIG. 5—CAST ALLOY 86:10:4 Al:Mg:Si
A little primary aluminum, but the alloy is largely a binary eutectic complex of Mg_2Si and aluminum. Unetched. × 125.

found in increasing the Mg_2Si beyond 0.9 per cent in the presence of 3 per cent copper. Reheating the quenched alloys for 1 hour at 50 or 100 deg. C. showed an inappreciable increase in hardness, while a slight softening was observed in the alloy containing very low Mg_2Si after heating at 150 deg. C. All except this latter sample showed a marked increase in hardness at 200 deg. C. but at 250 deg. C. the hardness decreased.

Alloys containing 15 per cent zinc instead of 3 per cent copper showed little increase in strength on aging; the maximum effect was obtained at 150 deg. C.

Alloys containing 3 per cent of nickel indicated that this element had less effect on the solubility of Mg_2Si than either copper or zinc. The maximum hardening was obtained with about 1.3 per cent Mg_2Si, and after heating at 200 deg. C.

In order to study the hardening of copper-aluminum alloys after quenching from a high temperature, a series of ten alloys containing from 0.5 to 5 per cent copper were cast, forged and quenched from 500 deg. C. After 5 days' aging, a small increase in hardness was observed, but in no case did Brinell hardness increase more than 10. The samples were then reheated for 1 hour at various temperatures. In the alloys containing 3 to 5 per cent copper, a somewhat greater hardness was obtained at 205 deg. C., and a still greater improvement after heating 2.5 hours. The maximum hardness would be obtained with an alloy containing 4.5 per cent copper, heated at 500 deg. C., quenched and subsequently reheated for about 3 hours at 205 deg. C. The amount of this hardening is considerably less than in similar alloys containing Mg_2Si.

To alloys containing 4 per cent copper and 4 per cent copper with 0.5 per cent manganese, varying amounts of magnesium silicide were added. With the 4 per cent copper alone, 0.55 per cent Mg_2Si gave a tensile strength of about 52,000 lb. per sq.in. after heating, quenching and aging for 4 days; reheating at temperatures above 100 deg. C. resulted in a loss in strength, although the elongation was improved up to 150 deg. C. With 4 per cent of copper and 1.35 per cent Mg_2Si (0.85 per cent magnesium and 0.5 per cent silicon), the strength, after quenching and aging, was 55,000 lb. per sq.in. The strength was increased to about 57,000 lb. per sq.in. by reheating at 200 deg. C.

In the alloys containing 0.5 per cent manganese and 4 per cent copper, a decided increase in strength was obtained by increasing the magnesium silicide from 0.55 to 1.35 per cent. The maximum strength was 56,000 lb. per sq.in. with the smaller amount of Mg_2Si and about 64,000 lb. with 1.35 per cent Mg_2Si (after reheating to 175 deg. C.).

The elongation of any one of the alloys of this series is not reduced by the aging process nor by reheating at higher temperatures up to about 150 deg. C. Above 200 deg. C. the ductility decreases rapidly.

The Effect of Bomb Corrosion on the Accuracy of Calorimetric Determinations

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THE practice of modern combustion calorimetry properly begins with the work of Berthelot,[1] who was the first to design an instrument in which the material under examination was burned in an excess of oxygen under high pressure. His bomb, because of its heavy platinum lining, was extremely expensive; in 1892, Mahler,[2] besides improving its mechanical design, substituted a lining of enamel for the more costly material.

A calorimeter bomb embodying many of the best features of those used today was described in 1894 by Atwater.[3] Corrosion was prevented by the use of a platinum lining or in lieu of that, of a copper lining heavily plated with gold. One of these in particular withstood 300 combustions before blisters appeared in the plating and 400 before the presence of copper could be detected in the washings.

Some years ago Prof. A. H. White furnished for the use of his classes at the University of Michigan a bomb made of steel only, which gave good service by virtue of the formation of an inner coating of dense adherent scale. Later, however, Monel metal was selected to replace the steel, with more satisfactory results.

In 1915 Prof. S. W. Parr[4] perfected a new acid-resisting alloy known as Illium to replace platinum in calorimeter bomb construction. This complex combination of nine different metals has the necessary tensile strength and is extremely resistant to both nitric and sulphuric acids. The first bomb constructed of this material was in constant use in his laboratory for months without showing deterioration, and the test of time has since proved it to be the equivalent of platinum for the purpose in question.

It is evident from this brief review of the work of the authorities on the subject that the necessity for providing a non-oxidizable inner surface for the bomb has been, almost without exception, tacitly assumed. It is clear that corrosion or oxidation of the metal, which invariably involves an exothermic reaction, increases the total heat to be measured by an amount

[1] *Compt. rend.*, vol. 104, p. 375 (1887).
[2] *Compt. rend.*, vol. 113, p. 774 (1891).
[3] *J. Am. Chem. Soc.*, vol. 25, p. 659 (1903).
[4] *J. Am. Chem. Soc.*, vol. 37, p. 2515 (1915).

equivalent to the quantity of metal dissolved, and that even should the injury to the instrument be overlooked, the expenditure of time and labor for determining the metal content of the bomb washings for the purpose of applying a correction could not be tolerated.

The Nickel-Lined Bomb

Of particular interest from the standpoint of this paper was the announcement in 1909 of the design of a new calorimeter by Emerson.[5] This instrument embodies many excellent mechanical features with respect both to ease of assembly and to the admission of oxygen. As advertised in current catalogs of dealers in scientific apparatus, bomb linings of three different metals are offered—viz, platinum, gold and nickel. The latter because of its low cost has apparently proved to be the most popular, especially as it carries the unqualified recommendation of the manufacturer for general work. Concerning this point, Charles J. Emerson in a private communication writes: "The nickel linings are perfectly satisfactory for the general run of calorimeter work, as the errors involved in the use of this type of instrument are well within the limits of accuracy of the other elements entering into the determination, as, for instance, the thermometric errors and those in sampling as encountered particularly in fuel work."

In view of this radical departure from established standards, since pure nickel cannot be considered especially resistant to oxidation, the work of determining the corrosion effect on nickel was undertaken, primarily to guide the technical worker in interpreting results obtained with this type of instrument and secondarily to throw light on the general question of standards for bomb construction. Manifestly if a relatively inexpensive metal will serve for instruments used in industrial laboratories, no logical reason can be advanced for providing gold or platinum.

Experimental Procedure

The work done was divided into Series I and II. In the first, a substance or mixture of known calorific value was burned in the bomb to be tested and the discrepancies between the values calculated and those found were measured. Thus the sources of error were determined. In the second series parallel samples of coal were burned in a standard bomb in which no corrosion could take place, and also in the nickel bomb. As before, the magnitude and sources of error were studied. Calorimetric measurements were made in each case with all the care prescribed for accurate work on fuels, following in general the methods of Stanton and Fieldner[6] as given in Technical Paper No. 8 of the Bureau of Mines. The thermometer used was certified by the U. S. Bureau of Standards.

Series I.—Combustion samples for Series I were made up of standard sucrose (Bureau of Standards No. 17), with a heat value of 3,949 calories per gram, mixed with relatively small quantities of pure rhombic sulphur. According to Thomsen[7] the molecular heat of combustion of the latter plus heat of solution is 142,400 calories, and calculations were made on that basis.

After each run the bomb washings were titrated with standard alkali, then analyzed for nickel by the well-known dimethyl-glyoxime method. Runs 1-5, as shown in Table I, were made with sugar alone, and since nitrogen was the only acid element present, the formation of $Ni(NO_3)_2$ is assumed. Referring again to Thomsen's figures, we find the value 83,420 calories for $Ni\text{-}O\text{-}N_2O_5Aq$, from which the errors due to corrosion were calculated. Where sulphur was added, as in runs 6 to 18, the predominating salt is $NiSO_4$ and the computation of error was based on Thomsen's figures of 86,950 calories for $Ni\text{-}O\text{-}SO_3Aq$. It is evident, of course, that some nickel nitrate is present in the washings from these later runs as well, but inasmuch as the heats of formation of the two salts are so nearly equal the actual difference in this case amounts to only a few calories. Nickel determinations were made in each case only after filtration of the washings with a view to the elimination of any nickel oxide that might be present, thereby insuring the presence of nickel salts only.

TABLE I—COMBUSTION OF SUCROSE AND SULPHUR IN NICKEL-LINED BOMB

1	2	3	4	5	6	7	8	9		10		11		12	13
No.	Wt. of Sucrose, in Grams	Wt. of Sulphur, in Grams	Wt. of Nickel Dissolved, in Grams	Free Acid (0.0898 N Alk.), in Grams	Acid Equiv. to Sulphur Added (H_2SO_4), in Grams	Heat of Combustion of Sucrose, in Cal.	Heat of Combustion of Sulphur, in Cal.	Heat of Formation of $Ni\text{-}O\text{-}N_2O_5$ In Cal.	In B.t.u.	Heat of Formation of $Ni\text{-}O\text{-}SO_3Aq$ In Cal.	In B.t.u.	Total Heat Calculated, In Cal.	In B.t.u.	Total Heat Observed, in Cal.	Percentage of Error (Ratio of cols. 9 and 10 to col. 11)
1	1.7430	......	0.0239	......	......	6,883	.....	32.5	59	.....	...	6,918.4	12,093	6,945.9	0.47
2	1.9057	......	0.0256	......	......	7,530	.....	36.0	65	.....	...	7,567.9	13,622	7,545.2	0.47
3	1.7939	......	0.0237	......	......	7,087	.....	32.2	58	.....	...	7,122.1	12,820	7,122.6	0.45
4	1.9850	......	0.0220	......	......	7,840	.....	31.2	57	.....	...	7,872.6	14,171	7,917.4	0.39
5	2.2390	......	0.0236	......	......	8,840	.....	33.1	60	.....	...	8,874.9	15,975	8,855.8	0.37
6	0.9500	0.0500	0.0636	0.0418	0.1500	3,751.7	222.5	....	..	94.2	170	4,068.4	7,322	4,079.7	2.32
7	0.9500	0.0733	0.0678	0.0998	0.2199	3,751.7	326.2	....	..	100.5	181	4,178.4	7,520	4,161.3	2.41
8	0.9500	0.0473	0.0583	0.0405	0.1419	3,751.7	210.5	....	..	86.4	156	4,048.6	7,288	4,072.0	2.13
9	0.9500	0.0588	0.0798	0.0220	0.1764	3,751.7	261.6	....	..	118.2	213	4,131.5	7,438	4,179.2	2.85
10	0.9500	0.0704	0.0785	0.0683	0.2112	3,751.7	313.2	....	..	116.3	209	4,181.2	7,528	4,128.2	2.77
11	0.9500	0.0511	0.0711	0.0286	0.1533	3,751.7	227.4	....	..	105.3	190	4,084.4	7,351	4,077.2	2.57
12	0.9500	0.0536	0.0755	0.0466	0.1608	3,751.7	283.0	....	..	111.7	202	4,146.4	7,463	4,166.4	2.70
13	0.9500	0.0647	0.0791	0.0493	0.1941	3,751.7	288.0	....	..	117.2	211	4,156.9	7,483	4,169.0	2.81
14	1.4250	0.0762	0.0872	0.0656	0.2286	5,627.3	339.2	....	..	129.2	232	6,095.7	10,973	6,101.9	2.12
15	1.4250	0.0864	0.1020	0.0616	0.2592	5,627.3	384.5	....	..	151.1	272	6,162.9	11,093	6,142.7	2.45
16	1.4250	0.1023	0.0976	0.0880	0.3069	5,627.3	455.2	....	..	144.5	261	6,227.0	11,209	6,216.6	2.33
17	1.4250	0.0656	0.0781	0.0484	0.1968	5,627.3	292.0	....	..	115.8	209	6,035.1	10,863	6,066.1	1.92
18	1.4250	0.0965	0.0891	0.0836	0.2895	5,627.3	429.4	....	..	132.0	238	6,188.7	11,140	6,155.4	2.13

TABLE II—PERCENTAGE COMPOSITION OF COALS USED IN SERIES II

Sample No.	Moisture	Ash (Dry Basis)	Sulphur (Dry Basis)	Nitrogen
1	5.88	15.42	4.25	1.17
2	5.72	17.67	4.15	1.19
3	2.69	10.71	3.70	1.46

Series II.—The coals used in the second series of tests, collected from Illinois fields, were chosen partic-

[5] *J. Ind. Eng. Chem.*, vol. 1, p. 17 (1909).

[6] Tech. Paper 8, Bur. Mines (1913).

[7] Landolt-Börnstein, Tabellen, 1912, p. 868.

ularly for their rather high sulphur values. Table II shows their content of non-coal substances.

The bomb used as a standard for comparison was one of the Mahler-Atwater type lined with platinum. As before, free acids were determined by titration and, since no corrosion was possible, the titer was a measure of the acids generated in the reaction. Similarly the coals were burned in the nickel-lined bomb and free acid and nickel contents of the washings were determined. Results are given in Table III.

Corrections and Sources of Error

Attention is directed to the fact that for the purpose of comparison the heat values of the coal given in columns 2 and 4 of Table III as determined by the two instruments are not corrected for sulphur. It should be noted, however, that in the regular practice of coal calorimetry a correction is invariably made for the difference between the heats of formation of the dioxide and the trioxide as they are generated in the furnace and the bomb, respectively, and for nitric acid produced. Formulated, this correction is

$$C = vk + 13w$$

where C is the number of calories, v the volume in cubic centimeters of standard alkali used in titrating the bomb washings, k a constant quantity of heat, which is a function of the strength of the standard solution, and w the weight in centigrams of the sulphur as determined separately.

TABLE III—PARALLEL COMBUSTIONS OF COAL WITH PLATINUM AND WITH NICKEL-LINED BOMBS

1	2	3	4	5	6	7		8		9		10
Sample No.	Heat of Combustion Per Gram, Platinum Bomb, in Cal.	Amt. of Free Acid Per Gram, by Titration Calculated as H_2SO_4 (0.0898 N Alk.), in Grams	Heat of Combustion Per Gram, Nickel Bomb, in Cal.	Amt. of Free Acid Per Gram by Titration, Calc'd as H_2SO_4, in Grams	Amount of Nickel Dissolved, in Grams	Heat of Formation of Ni-O-SO_3Aq, in Cal.	in B.t.u.	Error* in Titration Correction, in Cal.	in B.t.u.	Total Error, in Cal.	in B.t.u.	Percentage Error
1	6,514	0.1720	6,696	0.0167	0.0694	103	185	47	85	150	270	2.35
	6,517	0.1716	6,703	0.0154	0.0768	114	205	47	85	161	290	2.47
2	6,379	0.1619	6,516	0.0070	0.0703	104	187	47	85	151	272	2.36
	6,412	0.1681	6,500	0.0192	0.0706	105	189	44	79	149	268	2.32
3	7,072	0.1336	7,702	0.0079	0.0670	99	178	38	68	137	247	1.93
	7,064	0.1320	7,181	0.0048	0.0673	100	180	39	70	139	251	1.96

* See "Methods of Analyzing Coal and Coke," Stanton and Fieldner, Tech. Paper 8, Bureau of Mines, pp. 33-34.

Inasmuch as only a small quantity of free acid remains in the washings from the nickel bomb in consequence of its reaction on the lining, as shown by comparison of columns 3 and 5, the value of v as found is too low, and the correction is consequently in error by an amount varying with the quantity of acid-forming constituents of the coal. For total error this value, which is tabulated in column 8 of Table III, must be added to that calculated for the heat of formation of nickel salts.

Any attempt to apply a correction for the heat of corrosion of the lining calculated as a function of the sulphur content of the fuel would not be feasible for the reason that with continued use the bomb becomes more and more roughened and pitted, thereby offering increasingly favorable contact to the acids present. Moreover the period between the time of ignition and that of washing the bomb must always be a variable affecting the accuracy of the correction.

It should be noted particularly that the values of absolute errors as given do not depend directly upon our calorimetric measurements, which include the reading of the thermometer, the calculation of corrections for radiation and the like, as well as the weighings and adjustments incident to a run, all of which offer opportunities for error, but upon two simple and highly accurate methods of chemical analysis—viz., the determination of nickel by the glyoxime method and the titration of an acid with a standard alkali solution. Of course, indirectly they depend upon Thomsen's work, which, however, is generally accepted.

Conclusions

In attempting to pass judgment on the merits of an instrument on the basis of results obtained in its use the matter of a standard of comparison is naturally of prime importance. A conservative estimate of the accuracy obtainable with a good oxygen bomb calorimeter is a figure well within 0.5 per cent. Naturally, this limit of accuracy assumes that operators of the calorimeter should be experienced, versed in quantitative procedure and reasonably careful.

In the opinion of the committee on coal analysis of the American Chemical Society, results obtained by a single analyst should not differ more than 0.3 per cent, while those obtained by different analysts should agree within 0.4 per cent. Reference to the accompanying tables will show errors as high as 2.5 per cent or more in the use of the nickel bomb, equivalent in the heat determination of a coal, for instance, to a mercury rise of about 0.15 deg. F. Inasmuch as no difficulty is experienced in reading accurately to 0.002 deg. F. with a Beckmann thermometer or with the Richards modification of the Beckmann instrument, it is readily seen that the inherent error of the instrument far exceeds that of the observer's eye or of the personal equation in general. It seems fair to say that greater accuracy than that obtained can be had with instruments of other types and of much lower cost or indeed by calculation from analytical data according to formulas that have been prepared for that purpose. Furthermore, the purchaser of an oxygen bomb outfit, who must make in any case a relatively large capital investment and whose use of the instrument must necessarily involve considerable care and expense, expects a fairly high accuracy. In buying a cheaper lining, therefore, he defeats his own ends.

With respect to the subject of standards in fuel technology, the growing tendency for large consumers of coal to purchase their supplies on rigid specification is increasing the demand for accurate calorimetry, inasmuch as the results must govern the question of bonus or penalty on settlement. An attitude of tolerance toward questionable technical methods naturally cannot be long maintained by either party to the transaction.

The authors wish to emphasize, in conclusion, the fact that this article is not, in general, a criticism of any particular instrument but of the use for bomb linings of nickel or any other metal so slightly resistant to corrosion as nickel proves to be.

Minerals, Earths and Clays of Latin America—II

The Natural Resources of the Central and South American Countries, Many of Which Are Now Undeveloped, May Yet Contribute Largely to the World's Supply of Manganese, Chromium, Tungsten, Vanadium, Molybdenum, Cobalt, Titanium and Zirconium

BY OTTO WILSON
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THE European war and the shutting off of supplies of manganese from Russia and India resulted in an important development for the production of that mineral in Latin-American countries, especially in Brazil. The Brazilian deposits are numerous and rich and the possibilities for future production are most promising. Some of these deposits had already been exploited, since for 25 years Brazil had been exporting manganese and up to the time of the war had had a total output amounting to about 500,000 tons. Exports rapidly mounted, however, when the American steel plants called on Brazil to replace Russian and Indian ores, and in 1917 they reached their highest point, 532,856 tons, valued at $14,321,003. This amount is about all the present railway facilities can handle. In 1918 exports dropped in quantity to 393,388 tons and in value to $11,460,760. In 1919 they amounted to 205,725 tons, valued at $4,397,468, and in 1920 to 453,737 tons, valued at $8,762,479. Lack of transportation facilities is said to be the only factor that retards development.

MANGANESE DEPOSITS IN BRAZIL

The greater share of past production has come from three states—Minas Geraes, Bahia and Matto Grosso—but other deposits are known in Maranhao, Parana, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Santa Catharina and São Paulo. The most important producing region is in Minas Geraes, near the iron deposits, and much of the ore is found in the same Itabira formation referred to in the preceding article of this series.[1] The chief deposits are near the stations of Lafayette and Miguel Burnier, on the Central Railway of Brazil. The leading mine of the Lafayette district, the Morro da Mina, has produced 2,000,000 tons of ore, and there is a proved reserve of 10,000,000 tons. The ore is of high grade, three analyses of the ore from the Lafayette district showing 49 to 51 per cent, 50 to 52 per cent and 50.47 per cent manganese, from 1 to 7 per cent silica, and 0.08 to 0.10 per cent, 0.12 to 0.15 per cent and 0.069 per cent phosphorus, respectively.[2] Some samples contain as high as 57.48 per cent manganese.[3] In the State of Bahia mining has been carried on in one district about 30 miles southwest of the port of Bahia, where there are estimated to be 700,000 tons of psilomelanic ore. The ore which has been mined averaged 43 to 49 per cent manganese, 3 to 6 per cent iron and 0.016 per cent phosphorus.[4] It ranges in size from small lumps to masses weighing as much as 1½ tons. In the State of Matto Grosso the two deposits that have been worked are a few miles south of the river port of Corumbá, to which river vessels ply from Buenos Aires. Some of the ore has as much as 60 per cent manganese, but the average is about 46 or 47 per cent, with 9 to 10 per cent iron. The deposits are in the hands of an English-American company which has a 70-year concession covering about 25,000 acres. There are reported to be many other deposits in these three states, as well as the others mentioned above, some of which are most promising.

Before the war the price per unit of manganese was about 14 cents, or $6.70 per ton, less moisture. There is an export tax of 10 per cent in Minas Geraes, based on the official valuation, which varies so much that in one year the amount of the tax per metric ton ranged from $1.80 to $3. The reserve of Brazil's manganese deposits is said to be sufficient to supply the United States with all its requirements almost indefinitely.

OTHER WAR-TIME SOURCES OF SUPPLY

Ecuador has been working some manganese deposits near Quito for export, but the only other country of South America besides Brazil that has shipped manganese in any large quantities is Chile. Prior to 1905 that country had sent over half a million tons to the United States. About that time competition from Russia and India developed and stopped production in Chile and there has been little since. In the 3 years preceding 1921 shipments amounting to about 15,000 tons were made, but these were discontinued in 1921 because of the high ocean freight rates. With lower rates it is thought that manganese ore can be sent to the United States with good profit and that this can be further increased by improving methods of handling. The chief production has come from the Carrizal district in the Province of Atacama and the Corral Quemada district in Coquimbo, but there are many others that have been or might be worked. The ore formerly mined carried up to 52 per cent manganese.

Cuba, Costa Rica, Panama and Mexico also answered the war-time call for manganese. The largest Cuban deposits are in the eastern end of the island, in the Province of Oriente. There are smaller deposits in the provinces of Pinar del Rio and Santa Clara. In Costa Rica manganese mining and exporting were started in 1916, when 1,305 tons was shipped. In the next year exports rose to 8,191 tons, and in 1918 to 9,893 tons. In 1919 they fell to 7,852 tons. In Panama seven manganese deposits were profitably working during the war, the bed lying near the historic port of Nombre de Dio, on the Atlantic side of the country. These were old workings that had been closed down since the beginning of the century and were reopened only in 1916. Other deposits, near Porto Bello, are said to be ex-

[1]For Part I see CHEM. & MET. ENG., vol. 26, No. 14, p. 631, April 5, 1922.

[2]Harder, E. C., "Manganese Ores of Russia, India, Brazil and Chile," *Trans.*, A.I.M.E., vol. 56, p. 60. Also Miller and Singewald, "Mineral Deposits of South America," p. 185.

[3]Derby, O. A., as quoted by Miller and Singewald.

[4]Hewett, "Mineral Resources of the U. S., 1914," p. 181, U. S. Geol. Sur., Washington, 1916.

tensive. The Mexican mines are found in Chihuahua, Puebla, Chiapas and Lower California, the manganese being often associated with gold, silver or iron. Production in 1917 amounted to 73 metric tons, in 1918 to 2,878 tons, in 1919 to 2,294 tons, and in 1920, according to preliminary figures, to 838 tons. The ore shipped to the United States has averaged 40 to 48 per cent manganese. Besides these countries, Uruguay has pockets and traces in all parts of the country, two or three of which are worked for local purposes, and one company in Argentina has offered to supply 200 tons of ore a month for export from that country, provided a market can be found.

Chromium Found in Brazil, Cuba, Guatemala and Mexico

In chromium production four countries are listed, although production in none of them has reached large proportions. These countries are Brazil, Cuba, Guatemala and Mexico, in each of which the deposits were opened up by the war demand. Brazil took the lead in exports, and in 1918 shipped 17,854 tons. This fell off in 1919 to 4,800 tons and in 1920 to 3,451 tons; the average value in the last year was $21.36 per ton. The Brazilian ore came from a single district, near Queimadas and Bom Fin, in the State of Bahia, but there are other deposits reported farther inland, near the São Francisco River. The ore shipped has run about 44 to 46 per cent chromic oxide. The producing deposit is owned and operated by Americans. In no other South American country have deposits of any importance been uncovered, although in Venezuela, on the Coro Peninsula, and in Colombia, near Antioquia, occurrences of the ore have been reported, and a blast furnace near Medellin, in the latter country, is said to have produced chromiferous pig iron.

The Cuban deposits have been surveyed, and since 1916 several thousand tons has been exported to the

FIG. 14—SOUTHEAST END OF THE MAIN WORKINGS AT THE TOP OF THE MORRO DA MINA MANGANESE MINE, THE LARGEST IN BRAZIL

United States. The figures are as follows: 1916, 35 tons; 1917, 17 tons; 1918, 8,963 tons; 1919, 14,693 tons; 1920, 710 tons; 1921, 600 tons.[8] The deposits are found in twelve groups, all within 25 miles and most of them within 10 miles of the north coast, beginning with the Province of Havana and extending to the eastern end of the island. The eastern part of Havana has one deposit and the Province of Matanzas has two. The most important sources are found in the Province of Oriente, south of Nipe Bay, near the Mayari iron mines of the Bethlehem Steel Co., which has been taking out the chromite. About 40,000 tons of ore is now in sight. Next in importance are the Cayoguan and Potosi deposits, where it is estimated that there is an apparent reserve of about 35,000 tons. These lie near the eastern end of the island northeast of Baracoa, and are owned by two groups of American interests. Deposits near the town of Camaguey are said to have reserves of 20,000 tons. Of prime importance also are the chromiferous iron ores of Cuba found along the northeastern coast. Although present

FIG. 15—SHARP CONTACT BETWEEN MANGANESE ORE AND ROCK IN MORRO DA MINA

Black line at left shows contact, the lightest material is rock, the remainder is ore.

in vast amounts, these ores have so far been mined only at Mayari.

The changed conditions brought about by the war caused the development of chromite deposits in Guatemala in 1917, in which year 182 tons was sent to the United States. This increased in the three following years to 1,212 tons, 1,686 tons and 1,122 tons, respectively. The ore is described as very pure, averaging about 58 per cent chromic oxide, and is especially valuable for chemical purposes. It is in serpentine and is found about 100 miles inland from Puerto Barrios. Nicaragua is also said to have deposits of unknown extent, from which small shipments have been made. A part of Mexico's production of chromite is of high grade, containing as much as 54 per cent chromic oxide. This occurs in the Department of Progreso, from which shipments have been made to the United States. Other deposits, also worked during the war, are found in the Department of Jalapa.

Tungsten Resources of South and Central America

Bolivia, Peru and Argentina are the South American producers of tungsten, the first named being the most important. The production of Bolivia in recent years, in concentrates of 60 per cent tungsten, has been as follows: 1913, 278 long tons; 1914, 272 tons; 1915, 780 tons; 1916, 2,987 tons; 1917, 3,827 tons; 1918, 3,363 tons; 1919, 1,963 tons. Four districts lead in tungsten production—viz., those around La Paz, Oruro, Potosi and Cochabamba—although the deposits are not confined to these regions. The mines are in or on the sides of the eastern Cordilleras, extending over about

[8] U. S. import figures.

400 miles of territory, from Puerta Acosta to Chorolque. The principal mines of the La Paz district are the fields of Palca or Yungas, and Quime or Inquisivi, with others of importance at Araca and Colquiri. In the Oruro district there are some important scheelite deposits at Conde Auque and elsewhere, and the Uyuni district has produced, according to report, some hübnerite of remarkable purity at Salasala and in other localities. Wolframite is obtained from a great number of mines. The deposits are generally in veins and are closely associated with tin, although many tungsten deposits contain little or no tin. The average cost of mining seems to be about $12 a ton at the mine.

Production in Peru, amounting to 200 to 500 tons annually, is practically confined to the districts of Conchucos and Corogno, both near the ports of Salaverry and Chimbote. Deposits are reported to be large but of low grade, and their working fluctuates sensitively with prices for the ore in Liverpool and New York. Production is almost entirely in the hands of Indians, and is carried on in a very primitive manner. Before the war German interests were a controlling element in tungsten mining.

The Argentine ores occur in the pampa range of mountains, an isolated range lying about 20 miles east of the Andes. The deposits are more abundant in San Luis and Cordoba, but also occur in La Rioja. The ores are found at an elevation of 2,000 to 5,000 ft. They consist of wolframite, hübnerite and scheelite, and are associated with ores of bismuth, tin, mica, copper and molybdenum. The veins contain ½ to 1½ per cent tungsten in unevenly distributed crystals, lumps and slabs, weighing up to 110 lb. Mining is of the crudest sort, and the deposits are seldom worked to any exact depth. Exports in recent years have ranged from 175 to 1,000 tons. A sample of the ore from Catamarca, sent to the United States, was found by the Bureau of Mines to contain about 80 per cent scheelite and 11 per cent silica. Mexico has deposits of tungsten ore,

FIG. 16—NATIVE CHOLO INDIAN CARRYING ORE FROM AN OLD SPANISH MINE

The method of handling is so crude that only about 60 per cent of the ore is saved.

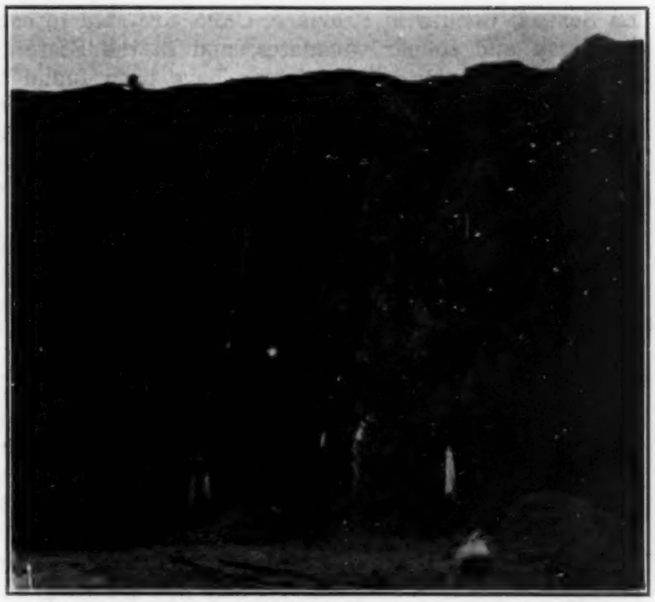


FIG. 17—OPEN CUT WORKING IN MANGANESE MINE

The dark portion at left is ore, the lighter material is rock.

which are apparently a continuation of those of southern Arizona. The known deposits apparently all carry scheelite, which is associated with copper minerals. The Mexican output is given as 187 metric tons of tungsten (doubtless concentrated ore) in 1917, 149 tons in 1918, 22 tons in 1919 and 33 tons in 1920.

Two-Thirds of the World's Supply of Vanadium

Of two other important steel alloys, vanadium and molybdenum, one department of one country supplies a very large part of Latin America's whole contribution. This is the Department of Junin, in Peru, in which the well-known Cerro de Pasco copper mines are located. This department contains numerous deposits of asphaltite, running as much as 500 ft. in length and containing an average of 1 per cent vanadic oxide.

The one deposit, however, which has attracted commercial attention is very much richer in vanadium. It is known as the Minasragua deposit and consists of a lens-shaped bed of mixed hydrocarbon and vanadic sulphide 300 ft. long and with a maximum width yet to be determined but probably between 30 and 40 ft. During the last 15 years this single deposit has furnished from 60 to 85 per cent of the world's supply of vanadium. The bed was originally of interest to miners because of the coal, but the sulphur content was too high to permit profitable exploitation and it had been abandoned when the manager of a nearby smelter discovered, in 1905, that the deposit was rich in vanadium. It was at once denounced and was later sold to an American company, which in turn has recently disposed of it to a company allied with the Bethlehem Steel Co. Since 1907 the total ore produced has carried a content of more than 5,000 tons of pure vanadium. The ore is called "patronite," and analyses give about 20 per cent vanadium and 59 per cent sulphur. The exploiting interests have established a large reduction plant near the deposit in which the ore is calcined to a sulphur content of only about ½ per cent, the vanadic oxide content being raised to 40 or 50 per cent. The Bethlehem Steel Co. plans to increase this, by further treatment, to 85 or 90 per cent before shipping.

The Arqueros silver mines in the Department of

La Serena, Coquimbo Province, Chile, are said to contain lead and copper vanadates, and in the State of Chihuahua, Mexico, the lead ores have been found to contain vanadium. The mineral is also reported from Zacatecas, Guanajuato, San Luis Potosi and Hidalgo, in Mexico. The asphalt of Mendoza and Neuquen, in Argentina, has a high vanadium content. When analyzed the ash has been found to consist almost entirely of vanadium salts, constituting 0.3 to 0.6 per cent of the whole. The Peruvian deposits, however, are the only ones in the world, aside from those in the United States, that are worked commercially.

Molybdenum and Cobalt

Peruvian production of molybdenum is not large, the total to date amounting to only a few tons. The producing deposits are in Juaja Province of the Department of Junín, but others are found in the Departments of Cuzco, Ancachs and Huanuco. The ore averages 5 per cent molybdenite, this being concentrated to 80 per cent for shipment. Molybdenum ores are known in the Mexican states of Sonora, Sinaloa, Oaxaca, Hidalgo and Jalisco, but only in the first named have they been developed to any extent. In the Sahuaripa district pockets of the pure mineral are found, and molybdenite, molybdite and wulfenite are found in lead and copper ores of other districts. In 1918 27 metric tons of ore was produced, in 1919 about 1.7 tons, and in 1920 about 0.6 ton. Bolivia has produced a few tons of

FIG. 18—OLD METHOD OF ORE CRUSHING IS STILL USED FOR TEST SAMPLES. POTOSI, BOLIVIA

molybdenum ore, the mineral being obtained from the Illampu range.

Cobalt is found in two South American countries, but production is spasmodic and of no great importance. In the Chilean Province of Atacama veins of cobalt oxide, arsenate and sulpho-arsenide, in which the ore averages 4 per cent cobalt, have been worked, the chief mines being about 30 miles from the port of Huasco. Rich veins of cobalt ore are found in the silver mines of this province, as well as in Coquimbo and Santiago. In Argentina cobalt ores have been reported from La Rioja and Catamarca.

Titanium and zirconium are found in limited quantities, the former in various parts of Latin America, usually associated with iron ores, and the latter in Brazil. The iron ores of São Paulo, Brazil, are said to be high in titanium and the diamond-bearing sands of Bahia and the monazite sands of the seacoast contain considerable amounts of both rutile and ilmenite. The zirconium of Brazil occurs in two forms, as a free zirconium oxide associated with silica, called baddeleyite or brazilite, and as an oxide combined with silica, known as zircon. The former carries 80 to 85 per cent ZrO_2 and the latter about 65 per cent. The chief deposits are in a mountainous region about 130 miles north of the city of São Paulo. They have not yet been fully explored, but appear to be very extensive. The average zirconium content of the ore which comes from Brazil is about 78 per cent.

Part III, which will discuss the Latin-American resources of the platinum metals, lead, zinc, antimony, bismuth, mercury, mica, monazite, asphalt, graphite, borax, potash and other minor minerals, will appear in a subsequent issue.

Byproduct Coke Operations for 1920

Figures have just been announced by the U. S. Geological Survey showing by states and by classes of coke the production, sales and use at producers' plants of byproduct coke made during 1920.

Of the total coke production, which was about 33 million tons, 26 per cent was sold by the producer and the remainder was used in the producers' plants. This indicates how largely the byproduct coke business is connected directly with the metallurgical industries. Of the sales about half, or 12 per cent of the total coke, was marketed as furnace size; 5 per cent of the total coke was marketed for foundry use, and 7 per cent was marketed for domestic and other similar fuel uses. Of the 7 per cent of the total coke which appeared as breeze or screenings, 2 per cent was sold and 5 per cent was used by the producer.

Reports to the Geological Survey indicate that the value per ton of the coke sold was approximately as follows: Furnace size, \$10.57; foundry size, \$13.86; domestic, \$8.92; breeze, \$2.22.

The steady increase in the ratio of byproduct coke plants to beehive ovens is reflected in the figures compiled on the byproducts obtained from coke-oven operations in the same year, shown in the following table:

BYPRODUCTS OBTAINED FROM COKE-OVEN OPERATIONS IN 1920 AND 1921

Product	Unit	1920 Production	1920 Quantity	1921 Estimated Production (a)
Tar	Gallons	360,664,124	174,363,696	233,000,000
Ammonia:				
Sulphate	Pounds	675,816,486	626,013,975	....
Anhydrous or free ammonia (b)	Pounds	65,777,259	62,076,772	....
Sulphate equivalent	Pounds	(938,925,522)	(874,321,063)	607,000,000
Gas:				
Distributed through city mains	1000 cu.ft.	476,485,744	53,220,824	308,000,000
Used in steel or affiliated plant	1000 cu.ft.		151,764,807	
Used under boilers etc.	1000 cu.ft.		25,430,288	
Light oil and derivatives:				
Crude light oil (c)	Gallons	109,709,915	1,067,045	71,000,000
Benzene: Crude	Gallons	8,747,572	1,510,420	....
Refined	Gallons	16,977,556	15,720,356	....
Motor fuel (d)	Gallons	57,645,462	55,764,265	....
Toluene: Crude	Gallons	287,142	....	....
Refined	Gallons	2,710,649	2,470,364	....
Solvent naphtha	Gallons	5,678,525	4,695,464	....
Naphthalene: Crude	Pounds	11,246,807	11,507,703	....
Refined	Pounds	2,921,282	2,941,059	....

(a) Estimated by assuming that the quantity of the several byproducts obtained bore the same relation to the known production of coke in 1921 as in 1920. The recoveries per ton of coal charged in 1920 were as follows: Ammonia (sulphate or equivalent), 21.4 lb.; tar, 8.2 gal.; crude light oil, 2.7 gal.; gas, 10.8 M cu.ft. (b) Mostly ammoniacal liquor, reported in content of NH_3. (c) The quantity of crude light oil refined by the producer amounted to 106,564,417 gal. (d) The benzene content of motor fuel ranged from 50 to 100 per cent.

Recovering Coal and Coke From Ashes

BY WILLIAM D. GREEN

MACROSCOPIC examination of the ashes discharged from certain industrial plants reveals the fact that these ashes or cinders contain a large amount of unburned coal as such together with a large percentage of coke.

A representative sample from a cinder pit containing several hundred tons showed by analysis that the ashes contained 57.8 per cent combustible matter and 42.2 per cent ash. The average analysis of the coal from which these cinders resulted is:

	Per Cent		Per Cent
Moisture	2.03	Ash	10.03
Volatile matter	44.00		
Fixed carbon	43.94	Total	100.00
		Sulphur	0.56

The purpose of the work described in this paper is to show that the recovery of the unburned portion of these cinders is possible, and that the product recovered constitutes a valuable fuel.

FIRST TEST

A sample of cinders from one of the factories of the Utah-Idaho Sugar Co. was ground to pass a 10-mesh Tyler standard screen having an opening of 1.651 mm. The sample was then treated by flotation in a Janney test machine using a mixture of raw pine oil and Barrett No. 4 flotation oil.

The results of Test 1 given in the accompanying table indicate a fair recovery of the combustible matter—viz., 70.6 per cent—and a satisfactory removal of the refuse—viz., 83.7 per cent. Out of every 100 tons of cinders there would be obtained 47 tons of recovered coal having an ash content of 15.2 per cent and a combustible content of 84.8 per cent.

SECOND TEST

Another portion of the same cinder sample ground as above was treated by flotation in a Janney test machine using a mixture of Barrett No. 4 flotation oil and crude turpentine. Toward the last of the test a small quantity of sulphuric acid was added in order to make a cleaner froth.

The results of Test 2 show a better recovery of the combustible matter—viz., 88.7 per cent. The removal of the refuse is very satisfactory, since the recovery of the combustible matter shows an increase over that of Test 1 amounting to 18.1 per cent.

The tests show that the carbonaceous matter can be removed from cinders with a satisfactory recovery.

RESULTS OF TESTS

	Per Cent By Weight	Analysis: Ash, Per Cent	Analysis: Combustible, Per Cent	Distribution of Original: Original Ash, Per Cent	Distribution of Original: Original Combustible, Per Cent
Test 1:					
Original cinders	100	42.2	57.8	100	100
Recovered coal	47	15.2	84.8	16.3	70.6
Refuse removed	53	68.7	31.3	83.7	29.4
Test 2:					
Original cinders	100	42.2	57.8	100	100
Recovered coal	61	16.0	84.0	22.8	88.7
Refuse removed	39	83.2	16.8	77.2	11.3
Test 3:					
Original cinders	100	42.2	57.8	100	100
Recovered coal	61.4	12.9	87.1	18.8	94.5
Refuse removed	37.3	91.6	8.4	81.2	5.5

The small quantity of acid used helped materially both the floating qualities of the coal as well as assisting in the dropping of the refuse. Knowing that the use of acid would be prohibitive in commercial work, it was decided to grind finer before going to flotation.

THIRD TEST

A third portion of the same cinder sample was ground in a ball mill to pass a 20-mesh Tyler standard screen having an opening of 0.833 mm. The sample was then treated by flotation in a Janney test machine using Barrett Salt Lake City heavy oil and after agitating for a few minutes adding a little crude turpentine. The Barrett oil did not produce much froth, but immediately upon adding the crude turpentine a voluminous clean froth formed.

A marked improvement over the other tests is shown in the results of Test 3. Undoubtedly in the coarser material much refuse was held mechanically in the pores of the coke, causing a high ash content. Out of every 100 tons of cinders there would be obtained 61.4 tons of recovered coal having an ash content of 12.9 per cent and a combustible content of 87.1 per cent, the latter being 94.5 per cent of the combustible matter contained in the original cinders.

The recovered coal can be burned as a powdered fuel, mixed with slack or mine run, or briquets.

Midvale, Utah.

Manufacture of Steel Gages

A SECOND meeting[1] of manufacturers and users interested in permanent gages developed the fact that satisfactory results could most probably be had with the proper one of the following steels:

1. Carbon steels; (*a*) 0.85 C, (*b*) 1.10 to 1.20 C, with or without 0.5 Cr.
2. Ball-bearing steel; 1.10 C, 1.40 Cr.
3. Non-deforming steel; 0.90 C, 1.25 Mn, 0.5 Cr, 0.5 W.
4. Case-hardening steel (chromium-nickel).

One manufacturer uses ball-bearing steel for plug gages. In his experience they are free from soft spots, wear very well, and will stand more abuse than carbonized surfaces. Thread gages were made of low-carbon steel, carbonized and heat-treated. Thread gages are more carefully used, because it is evident that they will not stand abuse. After the usual quenching and drawing operations, the gages are rough ground to aid in relief of internal strains. Then the gage is reheated to 20 deg. under the original draw, and slowly cooled. High-class work is drawn a third time, in an effort to completely "season" the piece against subsequent dimension changes.

Another manufacturer uses ordinary machinery steel for thread gages and miscellaneous gages and parts: C 0.20 to 0.30, Mn 0.90 to 1.10, Si below 0.20, P 0.06 to 0.08, S 0.06 to 0.08. Plain plugs and ring gages are made of 1.00 to 1.10 carbon steel. Blanks are normalized after rough forming by heating to 1,475 deg. F. and cooling in oil. Plugs up to $\frac{5}{16}$ in. are carburized in cyanide at 1,425 deg. F., for 10 to 20 minutes, depending upon the size, cooled in air, reheated in cyanide to 1,420 deg. C. and quenched in soluble oil. Larger plugs and rings are carburized in 1 part new charred bone and 2 parts used bone at 1,425 deg. F. for 2 to 5 hours, depend-

[1]See "Permanence of Steel Gages," CHEM. & MET. ENG., vol. 26, p. 248 (Feb. 8, 1922).

ing on size, and quenched in oil. Seasoning consists of ten alternate dips in boiling and cold water, each immersion bringing the entire mass to temperature. The chief difficulties experienced in this program is that ring thread gages will change in size excessively, some expanding and others contracting, a difficulty probably due to non-uniform steel rather than heat-treatment.

Thread gages for artillery ammunition ordinarily give a life of about 6,000 tests. Recently some gages which are still good after 50,000 tests were made by the Cleveland Twist Drill Co. of stock steel of the following composition:

Carbon	0.99	Silicon	0.24
Manganese	0.35	Sulphur	0.026
Phosphorus	0.012	Chromium	1.47

These gages were rough machined and annealed at 1,425 deg. F., taking 3 hours to bring the steel up to the heat and holding it there for 7 hours. They were then cooled slowly, after which the gages were finished, then hardened at 1,500 deg. F., quenched in oil and drawn to 350 deg. F.

They were heat-treated to produce a fine structure in the annealed condition. They machined easily, hardened uniformly without appreciable distortion and when finished had a smooth surface capable of resisting wear due to friction.

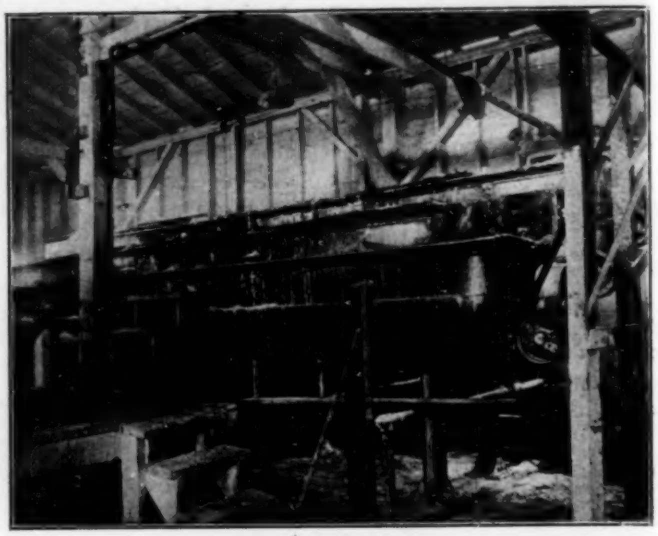
The analysis is close to that of the steel used in the races of the best ball bearings. It is not a high-priced steel, has a wide heat range, low risk in heat-treatment, changes but little in hardening or afterward, and the tools that are made from it are extremely tough. A thread gage made from this steel should cost less than one of machinery steel, pack-hardened, because the cost of pack-hardening would be more than the difference in the cost of the steel. Pack-hardening, if at all satisfactory, requires not less than 8 hours, while a gage made of the steel mentioned can be satisfactorily hardened in 10 minutes.

By accident, when these gages were made, the manufacturer left only 0.005 on pitch diameter for finish after hardening, but the gages cleaned up and took a very good finish. This shows conclusively that the steel used showed no appreciable change in hardening.

Improved Type of Continuous Crystallizer

Among the newer forms of chemical plant equipment designed for economy in operation is the Swenson-Walker continuous crystallizer shown in the illustration herewith. The internal moving parts of this device scrape across the internal semi-cylindrical surface of the troughs with such a small margin of clearance that caking on the surface is made impossible. The movement is sufficiently slow that the material which is crystallizing in suspension is not moved fast enough to produce much more than a minimum of fine material, while the shape of the flights is such as to produce a very slow, easy, forward movement of the entire mass of material at a rate just commensurate with the production wanted.

Tests carried out on the apparatus operating on the production of trisodium phosphate showed a weighed production of exactly 10,000 lb. in 12 hours, with an excess production in the form of crystals in process which were not present at the beginning of the 12-hour run. The effort was then made to test out the apparatus for continuity of operation and without any difficulty a run of approximately one week was carried through at or above the rated capacity of 10 tons per hour.



THE SWENSON-WALKER CONTINUOUS CRYSTALLIZER

The power consumed for the above-mentioned tonnage was only within the normal load of a 2-hp. motor. The water consumption for cooling was less than 5 gal. per minute, due to the fact that the entire apparatus is set up to run on the principles of a counter-current heat exchanger, and where it is possible to arrange the heat balance of a chemical plant properly, there is actually a very small amount of heat lost when using this system. This is particularly true due to the fact that the flow of cooling water, as well as the production of crystals, is continuous.

The question is often asked with reference to crystallizing problems whether a larger crystal can be obtained. The answer to this depends on the comparison which is made, but in the present instance it was found that instead of the previous figure of 65 per cent of the crystals being held over a screen of a certain size, the uniformity with which the crystals were produced raised this figure to 85 per cent. In other words, the dry fines produced in the plant were not over 45 per cent of the previous production, the fine material in this case, as in a great many others, being of far less market value.

The entire crystallization process need occupy only a part of the time of one man.

Recent Work on Reclamation of Molding Sand

The American Steel Foundries Co. has permitted a representative of the Molding Sand Research Committee to make a digest of the sand reclamation work carried on by its engineering staff.

After experimenting on different lines and thoroughly going over methods employed in other plants, a process of reclaiming old sand called "centrifugal scrubbing" was developed.

After establishing the principle of this method, equipment was designed which permits a recovery of about 70 per cent of refuse sand. Cost figures for 1921 show that a ton of reclaimed sand costs about $1 against the cost of new sand at the plant of $2.65 to $3.85 a ton. The process involves cleaning the sand grains of adhering fused material, then separating by air currents the good sand from the bad material.

The report covers the theory of sand reclaiming, centrifugal air-scrubbing process, cost of reclaiming sand by the latter process, and a description of the proposed sand-reclaiming unit.

Static Electrical Charges Detected by Neon Tester

By B. E. Shackelford, Ph.D.
Physicist, Westinghouse Lamp Co.

NEON, one of the rare gases of the atmosphere, has recently been made to serve as the basis of a convenient indicating device for the testing of high-tension electrical circuits. It now appears that this device, which was originally developed as an ignition gage for gas engines, may have a wide variety of uses in fields far removed from that of the automobile. The neon tube is especially sensitive to static electricty, and it may prove of great utility in detecting such charges in chemical plants and other factories where static electricity is regarded as a dangerous source of trouble.

During the last few years there have been many instances[1] of fires and explosions in mills, elevators and chemical factories caused by the discharge of static electricity which had gradually accumulated in the presence of flammable dust or vapors. Recently there was described in the columns of this magazine an explosion[2] of an agitator which was being filled with naphtha. Apparently this explosion was caused by the fact that the naphtha had become charged with static electricity while being pumped through pipe lines. The recent investigations of the Bureau of Chemistry and of the U. S. Grain Corporation have shown that one of the major fire and explosion hazards around grain elevators, flour mills, aluminum-powder factories, rubber plants, etc., is the accumulation of static electricity. It is, of course, always intended that such static charges be drained off by ground wires, but it is a fact that this desired end is not always attained. Pulleys, belts, grinding equipment, revolving reels and similar types of equipment are the most likely sources, and attention is usually given to their proper grounding. Sometimes, however, static accumulates in places where it is unsuspected and at other times it is found in places which are difficult to ground.

Description of the Neon Detector

The type of detector developed by the Westinghouse Lamp Co. and marketed under the trade name "Spark C," is an adaptation of the familiar Geissler tube. It is well known that the discharge of electricity through any such tube yields a glow, the color of which depends primarily on the gas contained in the tube. Pure neon is used in this instance both because of the ease with which it passes an electrical discharge and also because of the resultant color, a bright orange red. Even in daylight and with only a very small current passing, the resulting neon glow is quite marked.

The neon-filled Geissler tube is suitably mounted in an insulating casing of convenient size and provided at one end with a small metal contact tip and at the other end with a small condenser plate. The capacity of this plate to ground is sufficient for the current necessary for operation so that when the tester is brought near a live high-tension line or is touched to a body statically charged, the characteristic neon glow becomes visible.

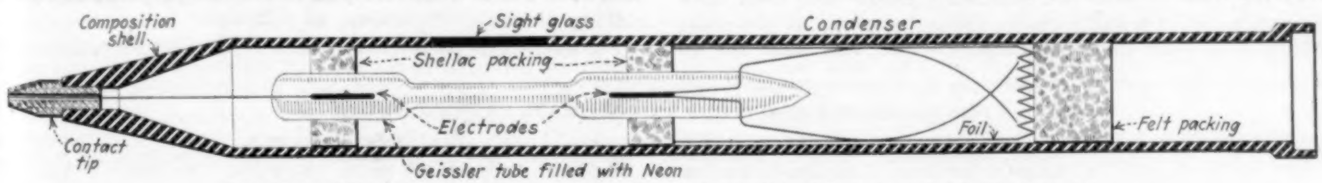
The neon tube of the standard device operates at any voltage above 350 volts, but in the mounting one lead is connected only to the condenser and this increases the voltage requirement somewhat so that the complete device begins to glow at about 700 volts of any ordinary frequency. Certain factors of design also affect the operating voltage to a certain extent.

Static charges, although they may contain comparatively little energy, have usually a very high voltage to ground and consequently give a brilliant glow in the tube. It should be noted that the glow is exhibited each time a current passes; with rapidly alternating current there is an apparently continuous flash. In the case of static there is a glow when the discharge passes through the tube to the condenser and another glow when the condenser is discharged by touching the point to the hand or to any other ground.

An indication of the sensitiveness of this device may be obtained by walking across a rug and touching the tip to a radiator, metal desk or other grounding device. The tester may also be made to glow by rubbing it with a piece of wool or, on particularly dry days, even by bringing it near the body. At other times a greater frequency of glow may be obtained by simply moving it near to and away from some portion of one's own clothing; a discharge will be noticed as the tester passes over particularly localized charges on the material. This great sensitivity is very useful in detecting static, and accordingly the field of application is quite extended.

Its Uses in Chemical Plants

It is possible for a most inexperienced workman to use this neon device to test out each portion of the equipment in a chemical-manufacturing plant as well as all parts of the conveyor systems, grinding and milling machinery, etc. It is usually found that although a system may apparently be well grounded, there are a number of places where there is a sufficient static charge to give an indication with the tester. The inspector, having it with him on his inspection trips, can immediately locate the sources of possible trouble and see that they are eliminated.



A SECTIONAL VIEW SHOWING CONSTRUCTION DETAILS OF NEON TESTER

In certain cases it is advantageous to drain off the static through the tester itself, connected directly to the ground wire. As soon as sufficient charge has accumulated to raise the voltage to approximately 350 volts, the tube flashes and calls attention to the presence of trouble. In this way there is available at all times an indicator of the rapid development of charges which otherwise might not be detected as soon as desirable.

Physical Laboratory,
Bloomfield, N. J.

[1] See articles by David J. Price, Chem. & Met. Eng., vol. 24, pp. 29, 473 and 737 (1921).

[2] "Explosion of Agitator Charged With Naphtha," Chem. & Met. Eng., vol. 25, No. 21, p. 949, No. 23, 1921, and vol. 26, No. 1, p. 4, Jan. 4, 1922.

Synopsis of Recent Chemical & Metallurgical Literature

The Oxidation of Ammonia.—The *Journal of the Society of Chemical Industry* (vol. 41, No. 4, p. 37T, of Feb. 28, 1922) contained a report of recent work conducted by the United Alkali Co. on the catalytic oxidation of ammonia for supplying oxides of nitrogen to its chamber sulphuric acid plants and in the production of nitric acid. The former application has been so successful that it is now installed at all the chamber plants of the company. The latter is not being used at present because of the prohibitive cost of concentration of the weak nitric acid produced.

The converter used in connection with the acid plant at Widnes, which has a capacity of 250 tons of O.V. per week, was made of aluminum and consisted of a square base with two inlets and a tapering hood connected with an aluminum bend. An electrically heated gauze was used at first, but was soon replaced by an unheated fourfold gauze. It was also found that aluminum was not suitable for the construction of the converters, as its melting point is dangerously near the proper conversion temperature. Cast iron seemed satisfactory for the hood except for the risk of rust particles dropping on the gauze. Enameled iron was found to be entirely satisfactory and later it was found that iron could be satisfactorily and cheaply protected by painting while hot with Seller's cement, a mixture of sodium silicate solution and barium sulphate. The gauze was 6 x 4 in. cross-section, each gauze being woven of platinum wire 0.065 mm. thick, 80 mesh to the inch, the four pieces being stitched together with platinum wire. The gauze is carefully cleaned before fixing in the converter by boiling in hydrochloric acid and washing with distilled water.

With a plant of this type, with no preheating of the gas, conversions by analysis of 86 to 89 per cent were obtained. The capacity of this unit was limited to about 25 lb. of sodium nitrate per sq.in. of platinum per day. Any attempt to increase the speed of the gas beyond this limit led to a falling off in efficiency and the appearance of ammonium nitrate and nitrite in the condensate. In an attempt to improve this yield a preheater was designed to utilize the heat in the exit gases for preheating the gas. It has an internal diameter of 12 in. across the tube plates, with 7 tubes each 2⅞ in. mean diameter and 2 ft. long. The tubes are either enameled or painted with Seller's cement. The inlet gas temperature is raised to about 300 deg. C. in the heat interchanger and the yield of the unit is increased to about 93 per cent as shown by the gas test.

It is reported that one platinum gauze was used continuously for 18 months before failure occurred at the point where it is held in the frames; another was used for 16 months before it was accidentally broken by a fitter, and others have worked for over a year and are apparently in good condition. The loss of platinum varies from 0.002 to 0.04 oz. troy per ton of 100 per cent nitric acid produced. In addition to this, allowance must be made for the depreciation of platinum, owing to the difference in the price between new platinum and scrap. With new platinum at £22 10s. per oz. troy and scrap at £19 10s., a fair allowance per ton of equivalent sodium nitrate for chamber working is 9d. for depreciation and 9d. for platinum loss, or a total of 1s. 6d. per ton.

The quality of ammonia used throughout has been commercially pure 25 per cent liquor from coke ovens or gas works, free from sulphides. It is stated that more risk of danger to the platinum exists from traces of iron rust than from any impurities normally to be expected in the ammonia.

The plant for the manufacture of nitric acid consisted of a converter with 6 x 4 in. gauzes, identical with those described above, coupled up with a set of towers belonging to an ordinary nitric acid unit. The absorption system consisted of three earthenware towers 3 ft. in diameter and 16 ft. 3 in. high, packed with rings and balls, followed by two smaller towers 2 ft. by 11 ft. high, packed in the same manner. Water or weak acid was circulated over the first three towers by means of air lifts, while a solution of soda ash or caustic liquor was circulated over the last pair of towers. Additional secondary air beyond that introduced by the air lifts could be introduced into the first tower if desired. The gases were cooled before entering the first tower by passing through a gallery of silica pipes. The total condensing space in the unit was 417 cu.ft., but an additional tower was later added at the front of the system to give increased oxidizing space, and this increased the total tower space to 533 cu.ft. Without a heat interchanger this plant produced the equivalent of about 1 ton of 100 per cent nitric acid per week, the acid being actually obtained at about 50 per cent HNO_3 with an overall yield of 78 to 79 per cent, of which 5 to 6 per cent was in the form of sodium nitrate from the final scrubbing towers. After the introduction of the heat interchanger, the output of the plant increased to the equivalent of about 1¾ tons of 100 per cent nitric acid per week with a yield of over 84 per cent. The acid was concentrated in the usual concentrating tower, using sulphuric acid as a dehydrating agent.

Sulphur and Oxides in Ordnance Steel.—W. J. Priestley, steel superintendent of the U. S. Naval Ordnance Plant, read a paper on this subject before the February meeting of the American Institute of Mining and Metallurgical Engineers. He noted that steels having high transverse ductility have not been made successfully in the basic open hearth, despite that furnace's ability to reduce phosphorus; consequently it has been usual to specify the acid process, although it requires low sulphur and phosphorus melting stock. The U. S. Naval Ordnance plant has been very successful in making steels by duplexing, as follows:

Pig and scrap (60:40 ratio) with 8 per cent limestone and

TABLE I—EFFECT OF SULPHUR AND OXIDES IN ORDNANCE STEEL

	Carbon, Per Cent	Manganese, Per Cent	Silicon, Per Cent	Phosphorus, Per Cent	Sulphur, Per Cent	Nickel, Per Cent	Tensile Strength, Lb. Sq. In.	Elastic Limit, Lb. Sq. In.	Elongation, Per Cent	Reduction in Area, Per Cent
Forging, 16 in diam., by 9 ft. long, 8½ in. bore; weight 5,000 lb. Average results from 10 forgings (or 20 bars) of each class										
Open-hearth steel*........	0.36	0.66	0.23	0.04	0.039	2.98	98,013	57,720	20.4	36.9
Electric steel............	0.34	0.64	0.22	0.012	0.008	1.16	95,435	64,010	24.5	58.3
Physical requirements.....	....	....	....	....	....	....	80,000	50,000	21.0	30.0
Forging, 11 in. diam. by 28 ft. long, 7½ in. bore: weight 6,000 lb. Average results from 10 forgings (or 40 bars)										
Open-hearth steel.........	0.37	0.65	0.21	0.040	0.044	3.02	104,785	73,162	19.6	39.4
Electric steel............	0.30	0.67	0.179	0.012	0.009	2.81	96,995	67,785	24.2	55.9
Physical requirements.....	....	....	....	....	....	....	90,000	55,000	18.0	30.0
Forging, 9 in. diam. by 28 ft. long, 5½ in. bore; weight 4,000 lb. Average results from 10 forgings (or 40 bars)										
Open-hearth steel.........	0.38	0.64	0.206	0.039	0.040	3.09	103,185	73,231	19.2	39.9
Electric steel............	0.34	0.65	0.212	0.014	0.012	2.87	100,340	72,610	23.2	52.5
Physical requirements.....	....	....	....	....	....	....	90,000	55,000	18.0	30.0
Forging, 26 in. diam. by 2 ft. long, 5 in. bore; weight 4,000 lb. Average results from 5 forgings (or 15 bars)										
Electric steel*...........	0.37	0.54	0.182	0.020	0.026	2.66	110,182	67,067	17.8	37.1
Electric steel............	0.35	0.72	0.169	0.006	0.008	2.91	108,681	77,038	20.2	49.3
Physical requirements.....	....	....	....	....	....	....	95,000	65,000	18.0	30.0
Forging, 9 in. diam. by 28 ft. long, 5½ in. bore; weight 4,000 lb. Average results from 10 forgings (or 40 bars)										
Electric steel*...........	0.39	0.53	0.16	0.020	0.025	2.65	95,245	64,979	19.3	37.0
Electric steel............	0.34	0.64	0.21	0.014	0.012	2.87	100,340	72,610	23.2	52.5

*These ingots were made by a private industrial plant during the war.

enough ore to lower the carbon to 0.25 is charged in a 75-ton basic open-hearth furnace. On tapping it contains C 0.23, P 0.007 and S 0.016; 2 lb. of 50 per cent ferrosilicon and 3 oz. aluminum per ton are added to prevent any oxides reacting with the carbon before the molten steel can be teemed into the two 40-ton electric furnaces. Here a new slag is made up of burned lime, fluorspar and coke, and adjusted from time to time; its total weight amounting to about 2,500 lb. The bath is held in a reducing atmosphere for 3 to 5 hours, and the finished steel contains C 0.32 to 0.40, P about 0.01 and S less than 0.01 per cent.

In the electric furnace, any oxides in the steel are rabbled to the top, and are reduced to metal by the carbon in the slag. When these reactions are complete, calcium carbide may form, which reacts with FeS or MnS, forming CaS, which is absorbed by the slag. It is important to remember, that deoxidation is preliminary to desulphurization, and it may be inferred that an electric heat which has markedly reduced sulphur has also produced a deoxidized metal.

Such steels appear to have a minimum number of slag inclusions, of one size and appearance—namely, minute round specks. High-grade acid open-hearth steel has, in addition, larger sheets or fibers of slag drawn out in forging. Basic steel includes both types of inclusions, but the elongated masses appear more brittle and badly shattered. Table I shows the excellent ductility in transverse specimens taken from large gun forgings made by the Naval Ordnance plant of duplex electric steel, as compared with acid open-hearth or basic electric furnaces from other sources, but possessing identical analysis except sulphur (and, inferentially, oxide).

The paper includes a very interesting discussion of the relative merits of electric and open-hearth steel, and detailed information on slag and metal analyses at various stages of the process.

Recent Chemical & Metallurgical Patents

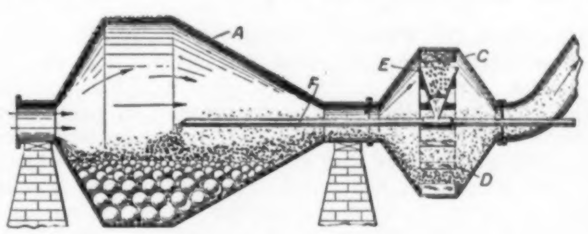
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Tanning.—A process of tanning consists in treating the hide with an arsenic compound which, if insoluble in water, has been rendered soluble or colloidal. In one example, a tanning agent is prepared by adding to a suspension of an insoluble compound of arsenious, arsenic, sulpharsenious, sulpharsenic, phenylarsinic or diphenylarsinic acid or arsenophenol a sufficiently large proportion of an alkali salt to produce a colloidal solution. In another example, the hide is treated with a free organic sulphonic acid of a hydrocarbon or with a synthetic tanning agent obtained by condensation and suphonation of a phenol and hydrocarbon used as a solvent for an arsenic compound, particularly a heavy metal salt of arsenious or arsenic acid. (Br. Pat. 171,693; not yet accepted. Gerb- und Farbstoff-werke H. Renner & Co., Hamburg. Jan. 11, 1922.)

Synthetic Tanning Agents.—Tanning agents are obtained by sulphonating the resinous condensation products prepared from phenols and formaldehyde with the aid of basic condensing agents. Starch, sugar, glucose or materials containing them may be mixed with the parent materials or the resins before the sulphonation. The sulphonation may be carried out so as to yield either readily soluble products or products which are sparingly soluble or insoluble. The readily soluble products have the property of solubilizing the sparingly soluble products or the unsulphonated resins or the insoluble phlobaphenes contained in vegetable tanning agents, and the resulting colloidal solutions may be employed as tanning agents. The process may be carried out by sulphonating one portion of resin to give an easily soluble product, sulphonating another portion to give a sparingly soluble or insoluble product, and mixing the two; or the process may be conducted so as to give first an insoluble product and solubilize this by further sulphonation; or an easily soluble sulphonation product may be mixed with the resin and the mixture sulphonated; or the resin may be sulphonated under such mild conditions that only a portion is sulphonated. The alkali salts of the sparingly soluble sulphonic acids dissolve the insoluble sulphonation products, and the resulting colloidal solutions may be used for tanning. In making the parent resins, the crude reaction product resulting from the alkali fusion of a sulphonated hydrocarbon may be used; ammonia of an ammonium salt, such as the sulphate, may be added to the alkali fusion to give ammonia for the condensation. Any of the tanning agents described above may be improved by oxidation—e.g., by means of atmospheric oxygen, ozone, hydrogen peroxide, potassium bichromate, permanganate, perchlorate, perborate or persulphate, chlorine or nitric acid, or by electrolytic oxidation. According to examples, phenol is heated with formaldehyde solution and aqueous ammonia, aniline, caustic soda or sodium carbonate, the resulting resin is sulphonated by concentrated or fuming sulphuric acid, the product diluted with water and free sulphuric acid neutralized by alkali; crude cresol or α- or β-naphthol may be substituted for the phenol; starch, molasses or concentrated or dry sulphite cellulose lye may be added to the above initial materials before condensation and sulphonation; mixtures are prepared from an easily soluble and an insoluble sulphonic acid, an easily soluble sulphonic acid and a non-sulphonated resin, an alkali salt of an insoluble sulphonic acid and the free sulphonic acid, an easily soluble sulphonic acid and quebracho extract; examples are also given of the use of alkali melts of resorcin and naphthols. (Br. Pat. 171,729. Gerb- und Farbstoff-werke H. Renner & Co., Hamburg. Jan. 11, 1922.)

Classifying Ground Material.—The patent describes an apparatus for treating ground materials, pulps or slimes for the separation of the fine material from the oversize and comprises a rotary vessel *C* fitted internally with scoops *D* which pick up the larger particles from the bottom of the vessel and pass them into a hopper *E* leading into a pipe *F* from which they are discharged by means of



a current of liquid or gas or both. The apparatus is preferably combined with a grinding-mill *A* to which the oversize is returned by the pipe *F*, while the fine material is discharged from the vessel *C* with or without the aid of a current of air; or, in the case of a mill for wet grinding, the fine material is allowed to overflow with water from the outlet of the vessel *C*. (Br. Pat. 172,525. H. W. Hardinge, London. Feb. 1, 1922.)

Nitric Acid.—In the preparation of nitric acid from the gases obtained by the oxidation of ammonia, a portion of the gases is absorbed in towers in water or dilute nitric acid and the remainder is liquefied by refrigeration. After a preliminary cooling, during which no condensation occurs, the gases from the furnace are passed through coils or other acid-proof apparatus, cooled by means of cold water, to condense as much as possible of the water present and to give a dilute solution of nitric acid. The uncondensed gases then enter towers fed with water or the dilute acid obtained as above described by condensation. Before the unabsorbed gases are liquefied they are dried by treatment in one or more washing towers with liquid nitrogen peroxide, in the manner described in specification 164,734. The acid obtained by absorption of the nitrogen oxides in dilute nitric acid is treated finally with the liquid nitrogen oxides obtained by refrigeration of the unabsorbed gases. (Br. Pat. 172,979; not yet accepted. C. Rossi and C. Toniolo, Legnano, Italy. Feb. 8, 1922.)

Book Reviews

THE DISTRIBUTION OF GAS. By *Walter Hole.* Fourth edition, rewritten and greatly enlarged. London: Benn Brothers, Ltd. 700 pp., 749 illustrations. Price 50s. net.

This fourth edition of the standard work by Hole requires no introduction to American gas engineers. The author has apparently made a very thorough job of revision and has extended the work materially beyond the form in which the third edition appeared 8 years ago. Particular attention has been given in the new edition to the domestic use of gas and two entirely new chapters have been introduced, one on "The Industrial Uses of Gas" and the second on "Inferential Meters."

The volume represents an extended review of the standard English gas engineering practice. For the young gas engineer it is a most complete text book; for the experienced engineer it is a convenient reference volume for many details which cannot readily be borne in mind even by the most experienced operator. However, for an engineer in American gas practice the volume does not approach in value its undoubted merit for the English operator. Practice in the two countries is notably different in many respects and the usefulness of the volume in the United States is thereby seriously curtailed. It will, however, form a valuable reference book in the library of any gas engineering organization, as it is very suggestive of methods and equipment which must be considered in any new developments. However, for American operation it should not be trusted too fully in detail.

As in the earlier editions, the volume is addressed almost solely to those engaged in the production or distribution of public utility gas supplies. It will find little use in the library of the chemical engineer, as the methods and apparatus described are limited almost altogether to those involved in public utility practice. R. S. McBride.

* * *

ECONOMICS OF PETROLEUM. By *Joseph E. Pogue.* New York: John Wiley & Sons, Inc. 375 pp., 151 figures. Price $6.

"The purpose of this book is to present, in perspective, the more important economic facts relating to petroleum; to interpret the changes that are rapidly taking place in this field; and to project the trend of these changes into the immediate future." Thus the author states the object of this volume at the beginning of his preface. And rarely does one find an author who has so satisfactorily accomplished his purpose as has Pogue in the present work.

The author takes the industry from its broad economic foundations through to the intimate detail of the various special products from petroleum, and paints for the reader in true proportion a picture of the entire petroleum industry. Not alone does the picture include the business of the industry itself, but it also shows clearly the relation of the problems of petroleum production, transportation, refining and marketing to each of the important related industries which are users of petroleum products. This presentation of the industry and the related industries is done in a simple, clear way without that distortion or bias which has so commonly destroyed the principal value of otherwise worth-while contributions to the literature of the oil business. In this case the author brings a wide experience and intimate knowledge of the fundamentals of the business to his task without giving any evidence of partiality for producer, refiner or user, an accomplishment which makes his book a most valuable contribution to the subject.

Although written strictly from the standpoint of statistics and economics, the author does not allow these tools of industry to become an end in themselves. His analysis and graphical presentation of the important figures which are essential to an understanding of the business have been accomplished in a simple fashion but without sacrifice of accuracy. Thus the economics are given very practical value and the statistics made really useful in the service of industry.

The author is to be strongly commended for his use of large units in presenting the data instead of presenting nine or ten significant figures in most cases where it is well known that only three or at the most four figures really have any meaning. Thus in practically every case "the unit has been so chosen that the data could be expressed by three digits with a decimal point if necessary." The extensive use of graphical methods for presentation also is most satisfying. In this particular the volume is exceptionally useful to the reader who wishes to get quickly an approximate idea of trends in the industry. Moreover the graphical presentation in almost every case has been made without resort to complicated charts of obscure meaning.

The mechanical form of the book quite justifies the writer's expression of appreciation to those who have assisted in the mechanical preparation of the work. The author is particularly to be commended upon the use of running heads on the pages which mean something. Thus one can identify the major subject of a chapter by the heading of the left-hand pages and subdivision of the subject under discussion by the right-hand page heads. This is a very practical advantage, particularly in a volume such as this which discusses many detailed phases of a single broad subject.

The volume represents a most comprehensive consolidation in systematic form of the fragmentary information and data which have been scattered through much valuable literature of the past few years. It will now be available to a wide variety of readers in a convenient reference text. A great deal of the value of the book is the fact that it presents data from quite recent periods, in some cases extending well into or through 1921. Being to a large extent statistical in its nature, it is to be hoped that the author will find opportunity to prepare new editions at frequent intervals. If this is done, it seems certain that the work will become a standard text, not only with reference to the petroleum industry itself, but also in connection with the great problem which the author cites, "the coming necessity for increasing the over-all efficiency of petroleum—a problem that concerns not only the producers and refiners of oil but the manufacturers of appliances that consume its products as well."

The author might well have added at this point reference to those who use this fuel-burning equipment, for in many cases the user of petroleum products will find quite as much of value in this volume as will the producer. This is true of those in the natural gas, manufactured gas, automotive, oil-shale and many other related industries. The problems of each of these, in their relation to the petroleum business, is clearly set forth, and accurately interpreted in this work. R. S. McBride.

* * *

AN INTRODUCTION TO THE ANALYTICAL CHEMISTRY OF THE RARER ELEMENTS. By *Louis J. Curtman, Ph.D.*, assistant professor of chemistry, chief of the division of qualitative analysis, College of the City of New York. 64 pp. New York, 1922. Published by the author. Price $1.25.

With the increasing industrial importance of the rarer elements has come a realization of the necessity for extending the usual courses in analytical chemistry so that the student may become familiar with the characteristic properties of this group of elements.

Dr. Curtman has prepared a sound foundation for this work by gathering together the characteristic tests for each of the rarer elements. All the reactions have been tried out carefully in the laboratory in order to eliminate those errors which somehow creep into the literature and are carried along with other data. The twenty-nine elements which are considered in detail are classified according to the usual analytical groups, but although some distinguishing tests are mentioned, no scheme for the separation of individual elements within a group has been included. It is to be hoped that Dr. Curtman will supplement this introductory text with one giving the analytical procedure for making such separations. Alan G. Wikoff.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Senate's Draft of Permanent Tariff Changes Duties on Certain Chemicals

In the tariff bill, which the Finance Committee has just reported to the Senate, the dye and chemical embargo is to be extended for 1 year from the passage of the act.

Among the other changes made in the House bill are the following: The specific duties on acetic anhydride reduced from 8c. to 5c., boric acid reduced from 2c. to 1½c., citric acid increased from 12c. to 18c.

There were slight increases in the lactic acid rates. Arsenic acid was made dutiable at 3c. per lb.; white arsenic, 2c.; formic acid, 4c.; gallic acid, 8c.; red oil, 1½c.; oxalic acid, 4c.; phosphoric acid, 2c.; pyrogallic acid, 12c.; stearic acid, 1½c.

The specific duty on potassium aluminum sulphate was reduced to ¾c. a lb., but the ad valorem rate for all other aluminum compounds was increased from 25 to 35 per cent. Amyl, butyl and isopropyl alcohol were made dutiable at 3c. per lb. Fusel oil was reduced from 6c. to 2c. per lb.

The rates covering ethyl and methyl alcohol were reduced from 15c. to 10c. per gal. Ammonium nitrate was put on the free list. Oxide of antimony was made dutiable at 1½c. per lb. and 25 per cent ad valorem. Gum arabic was taken from the free list and made dutiable at ½c. per lb. Half a cent was added to the rate of barium chloride. Barium hydroxide was inserted in the bill with a rate of 1¾c. per lb. The barium nitrate rate was increased ½c. The rate on barytes is fixed at 1¼c. per lb. Bismuth compounds were increased from 25 per cent to 35 per cent ad valorem.

As had been previously announced, intermediate and finished coal-tar products were made dutiable at 50 per cent ad valorem and 7c. per lb. and 60 per cent ad valorem and 7c. per lb. The ad valorem rates were increased from 30 to 50 per cent and from 35 to 60 per cent respectively. The bill instructs the Secretary of the Treasury to prepare standards of strength for each dye.

Compounds of cellulose were added to the bill and made dutiable at 35 per cent ad valorem. Potassium and sodium cyanides are made dutiable at 10 per cent ad valorem. The ad valorem duty for formaldehyde was stricken out and specific duty of 2c. per lb. inserted. A rate of 8c. per lb. is provided for solid formaldehyde and 10c. per lb. for hexamethylenetetramine. The rate on refined glycerine is reduced from 3c. to 2c. per lb., bromine is dutiable at 5c. per lb. and bromine compounds at 8c.

Duties on oils are fixed as follows: Coconut oil, 4c.; cottonseed oil, 3c.; peanut oil, 4c.; soya bean, 3c., the latter to be admitted free if it is to be used in the manufacture of articles unfit for food. Copra, palm nuts, rapeseed and other oil-bearing seeds and nuts were added to the free list, as was nitrate of potash.

England Stands Firm on Dye Protection

A recent attempt to repeal the British dyestuffs protective legislation failed in the House of Commons by a fairly large majority. In moving the repeal of the legislation it was charged that British Dyestuffs, Ltd., had furnished only very inferior products at very high prices and that the consuming trades were being seriously hampered by lack of satisfactory colors. The government warmly defended both the company and the protective laws.

New Chemistry Building for University of Missouri

The University of Missouri, Columbia, Mo., has taken bids and will soon award a contract for the erection of a new chemistry building at the institution, to cost $125,000.

Action of Senate Finance Committee in Extending Embargo Has Encouraging Features

While the action of the Senate Finance Committee in deciding to recommend the extension of the embargo on certain dyes and chemicals for 1 year is a disappointment in view of the inadequacy of the time period, the significant feature of the committee's action is the acceptance of the embargo principle. Moreover, it is confidently expected that either the time period will be extended by action on the floor of the Senate or the President will be empowered to extend it if he should deem it necessary. The hope is expressed that the Finance Committee itself will include such a provision in its bill.

It is pointed out that the President has at hand the service of the entire administrative machine to determine whether or not the embargo should be extended. The feeling among chemical manufacturers is that any impartial and intelligent survey of the situation will develop the absolute proof that the embargo must continue if there is to be vigorous development of the new organic chemical industry. If such a provision is placed in the bill, it is believed that development will go forward with full confidence that the requisite protection will be forthcoming.

In that connection it is pointed out that provision must be made for the establishment of a well-equipped laboratory, manned by experienced chemists, to aid the dye and chemical division of the Treasury Department. The customs service must have this adjunct, it is declared, to enable it to guard against false concentrations, undervaluation and false labeling.

Another Week of Sideshows at the Dye Investigation

There is now no doubt in anyone's mind, even including Senator King's, that the stories of an American dye monopoly are fairy tales. The investigating committee is being treated to many sidelights and personal animosities which if one is detached from the industry may have a slightly humorous flavor. All of the old tariff fights are being reviewed and some new attitudes are occasionally developed. On the whole the conduct of the investigation leaves a good taste in one's mouth. It has progressed fairly rapidly and the conclusions are likely to be definite.

Exoneration of Dye Makers Expected

That the Shortridge committee will exonerate the manufacturers of dyestuffs of the charges which were made against them is evident. The record will be unique in Congressional annals, for never before have such sweeping charges been made against any group and been subsequently found to contain so little meat. It is really one of the best things that could have happened to the industry, for it shows it in an extremely favorable light. It has given the organic chemical manufacturers an opportunity to spread on record a full account of their history and their needs. Nothing could have been more salutary for the industry than the necessity of showing its inmost soul to the public and the legislature. Its needs now come into stronger light than they did in the Senate and House committee rooms. The veiled and open hints that there was a monopoly which were freely used at those times by opponents of the industry are completely and forever eliminated by this investigation.

Prominent Textile Man Testifies in Favor of Embargo

Henry B. Thompson, president of the U. S. Finishing Co. and also president of the American Association of

Finishers of Cotton Fabrics, chairman of the Dye Advisory Committee of the War Trade Board and member of the Dye Committee of the Textile Alliance, testified at some length last week. His company manufactures 300,000,000 yd. of cloth per year and operates plants in Connecticut and Rhode Island. He took occasion to deny the charges made by Senator King that he had in any way benefited by his membership on the dye committees. He further stated that Mr. Poucher of the du Pont Co. did not dominate the committees, an additional charge from Senator King. He then went on to analyze the opposition to the dye embargo. There are three main groups. The first consists of the manufacturers of textiles who are selfishly interested in obtaining lowest prices for dyes. The second group is small but noisy. It is composed of manufacturers who are anxious to obtain a special color "without which their industry will perish from the face of the earth." Mr. Thompson did not think the position of these manufacturers was at all justified. He said that his company had been able to accomplish all of its numerous dyeing effects with American colors pieced out with German reparation dyes obtained through the Textile Alliance. The third group is the friends of the importers who will sign anything which the importers put in front of them.

Opposition to Dye Industry Will Drive Consumers Into the Hands of the Cartel

Mr. Thompson could not understand why adequate protection to the organic chemical industry should be opposed, when such opposition, if successful, would land us with the hands of the German dye cartel at our throats. In reply to a question by Senator Shortridge Mr. Thompson said that he was convinced that a protective tariff would not adequately protect the industry.

He presented some interesting figures on the price of about eighteen dyes which his company purchases on a competitive basis and showed that the price within the last 18 months had dropped 50 per cent as a result of the strenuous competition. This certainly indicated the reverse of a monopoly. In conclusion he said that users of dyes generally supported the present legislation and that the cotton industry as a whole would welcome its continuation.

Herty's Accuracy and Motives Attacked by Members of Metz' Staff

He was followed by Eugene R. Pickerell, of the staff of Herman A. Metz, who began by attacking both the accuracy and the motives of the report submitted by Charles H. Herty, president of the Synthetic Organic Chemical Manufacturers Association. The report makes five points: 1. The German pre-war prices of dyestuffs were no less than those obtained on the home market during 1921. 2. Variations in the home market price averaged 356 per cent. 3. Export sales prices varied 617 per cent during the same period. 4. German export prices to the U. S. were three to fourteen times the pre-war prices. 5. Germany can manipulate prices so as to offset the protection given by any duty.

Dr. Pickerell stated that these figures were not fair, that they represented eighty dyes picked out to show maximum variations, that the variations were entirely due to fluctuating exchange and that while many of the German dyes were down to pre-war basis the American dyes were selling at three times the pre-war values. He further states that the American toy and surgical instrument industry has more difficult problems to face than the dye manufacturers.

The dye manufacturers will answer these statements at the hearings this week.

Metz Fails to Produce Evidence That the Dermatological Institute Is a Commercial Organization

To the unbiased observer this particular controversy must seem irrelevant to the main subject and rather inspired by a personal malice than by an earnest desire to see justice done. The testimony of Jay F. Schamberg, director of the institute which manufactures salvarsan, was given last week. He was cross-examined by A. C. Vandiver, attorney for H. A. Metz. The substance of the cross-examination was to prove that the Institute should not be exempt from income taxes, since it was competing in the market with commercial firms. It developed in the testimony that all of the profits from the sale of salvarsan manufactured by the Institute are invested in research work and that not one penny of it is taken for personal profit. Furthermore that the Institute could not compete with Metz recently and the latter had obtained all the cream of the government orders. Senator Shortridge remarked that if institutions like the Dermatological Institute were not permitted to compete with commercial firms it would at once sweep away all charitable work by doctors and lawyers, eliminate free hospitals and reduce everything to a commercial basis. Dr. Schamberg said that the Institute in its whole existence could not boast of profits such as Mr. Metz had made in any single year.

Acceptance of Ford Offer Unlikely, but Congress Will Authorize Completion of Dams

That Congress cannot accept or reject the Ford or any other Muscle Shoals offer has been emphasized since the return to Washington of the Senators and Representatives who recently paid a visit to the project. To bargain and to adjust contracts is a function for which Congress is not equipped. For that reason there is increasing support for Representative Kahn's proposal that a commission study the problem and recommend the specific legislation desired. In the meantime the government can carry along the construction of the dam and in that way clear itself of any charge of a policy of delay. Since it will take 3 years to complete the dam, there would be ample time for the commission to deliberate and for Congress to pass upon the legislation which would be recommended and be in a position to make a more intelligent decision without having held up the project. This will permit the administrative departments of the government, which are accustomed to the negotiation of contracts, to approach the proposition in a business-like way.

One effect of the discussion of the various offers has been to make practically certain that Congress will appriate sufficient funds to keep the work going on the dam. There is reason to believe that the Senate will approve a rider on the War Department appropriation bill providing about $7,000,000 for the work during the next fiscal year.

Hearings on the whole proposition have been begun by the Senate Committee on Agriculture. The Kahn committee, which recently completed the hearings on the House side, is now meeting in executive sessions to determine its course.

Officers of Synthetic Organic Chemical Manufacturers Association Elected for 1922

The Synthetic Organic Chemical Manufacturers Association of the United States held its first annual meeting at the Hotel Pennsylvania on Friday, March 31.

Officers for the ensuing year were elected as follows: President, Charles H. Herty; vice-presidents: Dyestuff Section, C. N. Turner, Newport Chemical Works, Passaic, N. J.; Intermediate Section, Charles A. Meade, E. I. du Pont de Nemours & Co., Wilmington, N. J.; Pharceuticals Section, Herman Seydel, Seydel Manufacturing Co., Jersey City, N. J.; Fine Organic Chemicals Section, P. Schleussner, Roessler & Hasslacher Co., New York City; treasurer, Donald McKesson, McKesson & Robbins, New York City; board of governors, vice-presidents, *ex officio,* and August Merz, Heller & Merz, Newark, N. J.; F. P. Summers, Noil Chemical & Color Works, New York City; Dr. S. Iserman, Chemical Co. of America, New York City; F. E. Singer, Butterworth Judson Corporation, New York City; W. T. Cashman, Grasselli Chemical Co., Cleveland, Ohio; S. W. Wilder, Merrimac Chemical Co., Boston, Mass.; Dr. A. S. Burdick, Abbott Laboratories, Chicago, Ill.; Donald McKesson, McKesson & Robbins, New York City; F. L. McCartney, Monsanto Chemical Works, St. Louis, Mo.; James T. Pardee, Dow Chemical Co., Midland, Mich.; Dr. Charles H. Herty, *ex officio.*

World's Largest Dam Part of Plans for Hydro-Electric Development in France

A tremendous hydro-electric power development, projected by a financial and economic group in central France, has been welcomed by the Minister of Public Works and approved by the Superior Council of Public Works. The report of this body states that before the end of this year the total water power developed in France will be 1,500,000 hp., or twice the total developed before the war. During the next 15 years it is hoped that a supplementary 3,000,000 hp. will be added.

The undertaking comprises the construction of four dams and four electrical plants at the estimated cost of 400,000,000 francs. The largest of these dams will be 114 meters high, including the base, or 35 meters higher than the Roosevelt dam. A million cubic meters of masonry would be used in the construction and the cost would be approximately 100,000,000 francs. This wall would form a reservoir covering 1,000 hectares, including the sites of eight towns. The plant at the base would be equipped to generate 150,000 hp.

When these proposals have been realized, the rivers Rhone, Dordogne and a part of the Rhine, together with all the waterfalls in the central mountain region, in the Pyrenees and the Alps, will have been brought under contribution. Shortage of labor combined with high cost of materials may, however, interfere with the realization of existing plans. Net cost of the works required to produce 1 kw. varies between 1,500 and 2,000 francs or $135 to $180 at present exchange rates. About 3,500,000,000 francs, or $350,000,000, will be required during the next 15 years.

Estimates place the total available hydro-electric power of France at 8,500,000 hp. The principal purpose to which it is proposed to divert the power thus brought under contribution is electrifying the French railroads. Estimated annual saving in coal would be 3,000,000 tons, over 5,000 miles of track. It would also be employed in French blast furnaces. The Council of Public Works does not recommend the harnessing of French streams and rivers for purposes of local lighting and motive power, except to a minor extent, but holds that the power would be best employed in a centralized form.

Hydro-Electric Development of Colorado River Would Harness Country's Greatest Power Source

The Colorado River Commission, of which Secretary of Commerce Hoover is chairman, is considering the problem of utilizing the 6,000,000 hp. available and at the same time meeting the irrigation needs of that section. Meetings of the commission began on March 15, at Phoenix, Ariz. The commission includes representatives of the seven states that contain parts of the Colorado River basin, Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming.

The first construction in the great development recommended by the Reclamation Service would be a dam at Boulder Canyon, Arizona, 600 ft. high. This would make available 500,000 hp., or nearly as much as that developed now on both the American and Canadian sides of Niagara.

The progress in long-distance electrical transmission will yet bring all possible power of the river into national use, it is predicted.

Must Lower Freight Rate on Acid

Contentions of the American Zinc, Lead & Smelting Co. that the freight rate on sulphuric acid in tank car loads from Hillsboro, Ill., to certain Ohio River crossings are too high were upheld by the Interstate Commerce Commission in a decision handed down March 8. The smelting company manufactures sulphuric acid at Hillsboro. Its principal competition comes from the sulphuric acid manufactured at Copperhill, Tenn. On March 1, 1921, increased rates were put into effect from Hillsboro to the Ohio River. Since that time, however, there have been various readjustments in rates which have been to the advantage of the producers at Copperhill. Under the new ruling lower rates must be put into effect.

Pulp and Paper Industries in Maine Developing Hydro-Electric Resources

The Central Maine Power Co. has been very active during the past year in developing hydro-electric power. At a recent meeting all of the officers were re-elected. H. D. Eaton of Waterville is president.

The Kennebec Pulp Co. of Skowhegan, Maine, has lately undergone several changes. Water power will be replaced by hydro-electric power. One large motor of 750 hp. and four small motors will be installed. This mill has been closed since last summer. It is reported that it will furnish the Keys Fibre Co. of Waterville, Maine, a considerable quantity of ground wood pulp.

J. A. Harris, general manager of the Oxford Paper Co., Rumford, Maine, announced Thursday, March 2, that his company had taken over the interests of the Rumford Falls Power Co. The power company operates a modern hydro-electric plant with present installation to develop 31,000 hp. The paper company thus assures itself of ample water and power supply for present and future needs.

Rumors are circulating that hardwood furniture factories may be located in Maine in the near future. This seems very probable since evergreen forests cut some decades ago have been replaced by hardwoods which are now abundant. Hydro-electric power is available at low cost. Efforts to utilize hardwoods for pulp manufacture are being made, but are not likely to lead to important commercial results in the near future.

Seven Terra Cotta Firms Indicted by Federal Grand Jury for Practice of "Open Competition"

Indictments charging conspiracy and monopoly in restraint of trade were returned against the following manufacturers of terra cotta by the federal grand jury on March 27:

American Terra Cotta & Ceramic Co., Chicago, W. D. Gates, president; Denver Terra Cotta Co., Denver, George P. Fackt, vice-president; the Midland Terra Cotta Co., Chicago, Hans Mendrus, president; Northwestern Terra Cotta Co., Chicago, Harry J. Lucas, vice-president; St. Louis Terra Cotta Co., St. Louis, R. F. Grady, vice-president; Western Terra Cotta Co., Kansas City, William Timmerman, president; Winkle Terra Cotta Co., St. Louis, John G. Hewit, vice-president.

The indictments charge that the companies, as members of the National Terra Cotta Society, participated in the so-called Eidy plan of open competition, the same plan that was condemned by the United States Supreme Court in the hard-wood lumber case.

According to the indictments, the terra cotta society divided the country into eastern, central and western districts. Manufacturers in one, it is charged, withheld from competing in another.

The indictment charges that each company reported daily on its transactions to district headquarters, which in turn informed the other members.

New German Nitrate Plant Reported

The *Berliner Tageszeitung* reports that a new nitrogen company has been formed at Munich named "Cosag" (Continentale Stickstoffwerke Aktiengesellschaft). The capital is fixed at 40,950,000 marks. The company will erect its first nitrogen works at Golling, near Salzburg, and has acquired the right to exploit valuable lime deposits situated only a few hundred meters from the site of the new works. Rights have also been acquired in connection with the use of current from electrical works now in course of construction.

Discussions at National Foreign Trade Conventions

"Financing and Expanding Foreign Trade" will be the basic theme of the Ninth National Foreign Trade Convention, which will be held in Philadelphia, Pa., May 10, 11 and 12. Leaders in American industry, commerce and finance will be among the thousands of delegates from all parts of the country who will study the problem of how to finance and expand the nation's foreign commerce.

Farmers Register Protest Against Duty-Free Oils —Claim Soap Lobby Threatens Dairy Products

Farm organization delegates from fifteen different states made a concerted, eleventh-hour effort on March 24 to obtain a pledge from the Senate Finance Committee that tariff protection would be given dairy products, fats and oils, against Oriental and South Seas competition which threatens if the tariff oil schedule goes through as it now stands.

They savagely attacked the so-called "soap lobby," declaring its demand for duty-free vegetable oils would sacrifice the prosperity of nearly 40,000,000 farmers and endanger the $70,000,000,000 capital now invested in American farms and dairies.

Senator Townsend read a bundle of telegrams just received from Michigan dairymen and farmers and agricultural college experts, which denounced the growing tendency for substitution of cheap vegetable oils in daily foods, referring especially to "oiled" milk, lard compounds, salad dressings, filled cheese and the like.

Chairman McCumber of the Finance Committee seemed to agree with the trend of thought by saying: "It seems hardly proper that one section of the country should live under the protection of high duties while another section of our people should be forced to meet the competition of the world's free trade." He inquired if the farmers' committee would favor a tariff that taxed vegetable oils destined for food uses, but admitted free such oils as would be used in soap-making.

C. F. Creswell, statistician of the Dairymen's League, presented evidence showing the immense amount of soya bean oil, copra and coconut oil, peanuts and peanut oil which would flow into this country from Manchuria and the tropics, where the yellow and brown races have well developed and growing industries.

The Senate Finance Committee has received about 25,000 letters from laundries and grocery men, instigated by the "soap lobby," according to Senator Calder, so a bitter contest is expected by the farmers.

Garabed Bobs Up Again to Aid Agriculture

Taking a leaf evidently from Henry Ford's book, Garabed T. K. Giragossian, through the instrumentality of Representative Riddick of Montana, again has placed his unlimited energy invention before Congress, this time with the idea of "aiding agriculture by providing facilities for nitrate plants, water for irrigation, and for promoting more efficiency in travel and transportation, through the elimination of expense or labor for motive power."

The resolution which passed Congress Feb. 8, 1918, has been amended by striking out the assertion that Giragossian is the first and original inventor or discoverer of the process. The new resolution provides "that any invention or discovery similar to the claim of Garabed T. K. Giragossian shall not have come into actual and general public use and demonstrated in a substantial manner to be feasible and practical prior to the demonstration of the 'Garabed.'" The resolution also states that "Garabed" is not electricity.

While Congress is no more skeptical of this alleged discovery than it was in 1918, the original resolution was passed when the country was desperately in need of additional power. Congress was ready to grab at any straw which carried with it the barest possibility of speeding up the war program. Under present conditions it is regarded as practically certain that no serious consideration will be given this proposition by Congress.

Water-Testing Methods Described

"Field Examination of Water," by W. D. Collins, has just been prepared as a mimeographed summary of the recommendations of the U. S. Geological Survey, superseding its earlier report on methods of field assay of water. Methods are given for determination of turbidity, color, iron, chloride, carbonate and bicarbonate, hardness, sulphate and calcium, and for computation of results. Those desiring a copy of the report can get it on application to the author at the U. S. Geological Survey, Washington, D. C.

March Meeting of Lehigh Valley Section of the A.C.S.

The Lehigh Valley Section of the American Chemical Society met in the Administration Building of Muhlenberg College, Allentown, Pa., on Thursday evening, March 30. Prof. S. W. Parr, head of the department of applied chemistry, University of Illinois, spoke on "Fuels."

Dr. Parr's discussion centered on the theory of coking or carbonization of coals and on the results obtained by him in his researches. He has developed a method of coking the so-called non-coking Illinois coal so as to make it suitable for domestic purposes.

International Nickel Co. Centralizes Research and Development Activities

Robert C. Stanley, formerly first vice-president, was recently elected president of the International Nickel Co. Mr. Stanley has ordered a reorganization of personnel, involving as its chief feature a new department of development and research with headquarters at 67 Wall St., N. Y.

The new department of the company is the outgrowth of a gradually maturing conviction that a study of its products and their successful use in the hands of the consumer is the key to the extension of tonnage distribution. Research departments at the mines, smelters and refineries of the company, established during the last few years, have now been crystallized into a headquarters organization in intimate contact both with its own plant developments and with outside engineering developments, touching on the use of nickel and Monel metal in all fields. This department will be under the direction of A. J. Wadhams, manager. Associated with him will be Dr. Paul D. Merica, director of research.

Mr. Wadhams has hitherto been manager of the large Bayonne refinery of this company and has for years been in direct charge of the manufacture of all of the company's products, and through this experience is fitted to an unusual degree for his new work.

Trade Associations to Be Studied for the U. S. Chamber of Commerce

A committee has been appointed by the Chamber of Commerce of the United States to study trade associations. The committee will concern itself chiefly with the service which trade associations can render to business and to the public. The members of the committee are:

Philip H. Gadsden, chairman, Philadelphia; president, American Electric Railway Association and formerly member of Federal Electric Railways Commission; vice-president, United Gas Improvement Co.

Thomas S. Adams, New Haven, Conn.; secretary, National Tax Association; professor of political economy, Yale University.

Fred R. Babcock, Pittsburgh; formerly president, National Wholesale Lumber Dealers' Association and of the Pittsburgh Chamber of Commerce; president, Babcock Lumber Co.

Charles J. Brand, Pittsburgh; formerly chairman, Cotton Distribution Board, and chief of Bureau of Markets, Department of Agriculture; vice-president and general manager, United Fruit Growers, Inc.

Henry S. Dennison, Framingham, Mass.; formerly director of planning and statistics, War Industries Board, and president of the Taylor Society; president, Dennison Manufacturing Co.

James R. Maccoll, Pawtucket, R. I.; formerly president, National Cotton Manufacturers' Association and chairman executive committee, World Cotton Conference; treasurer, Lorraine Manufacturing Co.

J. D. H. Morrow, Washington; vice-president, National Coal Association.

Alfred Reeves, New York; secretary, National Automobile Chamber of Commerce.

George Rublee, New York; formerly member of Federal Trade Commission and delegate to Allied Maritime Transport Council.

Imports and Exports of Chemicals

Imports of chemicals on the free list during February were valued at $4,044,647. The imports of dutiable chemicals were valued at $2,713,180. This shows a decrease as compared with February of 1921, when imports of free list chemicals were valued at $5,306,361. The imports of dutiable chemicals in February, 1921, were valued at $2,129,903. The figures are those of the Bureau of Foreign and Domestic Commerce.

The principal increase in importations was in the gum group. There was a decided increase in the imports of chicle and in camphor. Imports of coal-tar products remained at practically the same level as in February, 1921. There also were increased importations of alkalis and alkaloids. There was a heavy decline in imports of calcium products.

Exports of chemicals continued to decline during February. The value of all chemicals exported was $7,665,830. In February of 1921 the value of chemicals exported was $10,559,429. As compared with February of last year, the principal decline was in the coal-tar group, in pigments, paints and varnishes, in fertilizers and in calcium compounds. Acetate of lime was an exception in this latter group. Exports of that commodity in February, 1922, were nearly double those of 1921. Exports of explosives increased decidedly, as did those of caustic soda.

Canadian Concern Lands Large American Order by Virtue of Low Merchant Marine Freight

Owing to the fact that the Canadian Government Merchant Marine was able to quote a low freight rate, the Sidney Roofing & Paper Co. has obtained an order for 1,400 tons of roofing felt from a concern in Los Angeles. This order will keep the plant, which since the fire last year has been moved from Sidney to Victoria, busy for 2 months.

In connection with the above it its interesting to note that the Canadian Government lost $2,210,724 in operating its merchant marine in 1921, excluding depreciation and interest charges. Interest owed the government for 1921 was $3,357,833.39. Depreciation was figured at $4,158,775.51.

Reorganization of Canada Pulp & Paper Co. Involves Unusual Legal Entanglement

With a view to the reorganization of the Canada Paper & Pulp Co., Ltd., which erected a plant and acquired extensive limits at Port Mellon, on Howe Sound, B. C., the Chartered Trust & Executor Co., as trustee for the holders of 7 per cent first mortgage gold bonds to the value of $1,000,000 in the paper concern, is suing the paper company and has named itself as one of the defendants, because it is also trustee for holders of a simultaneous issue of 6 per cent redeemable debenture stock, the owners of which are likewise interested in the reorganization. While this seems to be rather a complicated legal tangle, it is understood to be really a friendly suit to clear the way to a reorganization of the concern. The Western Pulp & Paper Co. was formed during the period of the boom in newsprint, but the plant now has been idle for several months.

Interstate Commerce Commission Regulations for Shipment of Explosives and Poisons

Regulations effective March 20 affecting the transportation of explosives and other dangerous articles have been promulgated by the Interstate Commerce Commission in Order 3666. The order includes regulations for the transportation of explosives by freight, including ammunition for cannon, chemical warfare ammunition and explosive bombs and mines of all kinds. Required methods of packing, marking and certifying these explosives are covered in detail. Rules for the handling and waybilling of acceptable explosives are expounded. A second section of the order covers the regulations for dangerous substances other than explosives, including prussic acid, bromacetone, brombenzylcyanide, carbonylchloride, chlorpicrin, cyanogen, mustard gas, police gas grenades and xylyl bromide.

French Chamber of Deputies Supports Private Operation of Alsatian Potash Deposits

The French Chamber of Deputies has recently been discussing the future régime to be applied to the Alsatian potash mines sequestrated by France. The commission formed to deal with the question had recommended that the mines be exploited by three companies to which concessions should be given. This recommendation was upheld by the government on the ground that competition among the three different companies would increase production and keep prices down. The Chamber voted against a counter-proposal by which the mines would remain entirely state controlled, but adopted by a vote of 289 to 250 a second counter-proposal by which the concession would be given to a single company, in which the workers themselves would have shares, in conformity with the law of April 26, 1917. The commission will now have to study this proposal and present another report.

Meeting of the American Electrochemical Society in Baltimore Announced

Preliminary announcements have been made of the program of the spring meeting of the American Electrochemical Society in Baltimore. The convention will meet first at the Emerson Hotel Thursday morning, April 27.

The morning will be devoted to a symposium on electric cast iron in charge of A. P. Hinckley and Bradley Stoughton. A golf tournament and visits to industrial plants will divide the honors in the afternoon. In the evening the members will have the privilege of hearing Prof. R. W. Wood of Johns Hopkins on the subject of fluorescence.

A number of timely papers are listed for the meetings Friday and Saturday morning as well as the presidential address of the retiring president, Acheson Smith.

It is urged that those who plan to attend should engage hotel accommodations at once. W. H. Boynton is acting as chairman of the local committee.

Present Status of Calvert Process for Alcohol From Water Gas

Owing to occasional references in current publications to the so-called Calvert process for making alcohol from water gas and hydrogen, inquiries have been made in England to determine the true status of the process.

The inventions of Dr. Calvert have to do with the production of both ethyl and methyl alcohols from carbon monoxide and hydrogen, the production of the latter being in a more advanced stage than that of ethyl alcohol, which is a later invention. A small test plant is now in process of construction, but present information does not extend beyond laboratory results. The production of both alcohols consists in running mixed carbon monoxide and hydrogen gases at controlled temperature and pressure over a catalyst producing either of the desired alcohols and an excess of CO. Approximate theoretical yields are not yet in sight.

Civil Service Examination Announced for Assistant Examiner, Patent Office

The U. S. Civil Service Commission announces an examination for assistant examiner in the Patent Office. Examinations will be held on May 10, 11 and 12 and on June 21, 22 and 23. The salary is $1,500 and applications must be filed on Form 1312. Subjects include mathematics, physics, mechanical drawing, language, technics and one optional.

Peat Bogs of Maine to Be Exploited

A contract probably has been, or will be, signed by the Peat Engineering Co., of Bangor, Maine, and others for the construction and operation of a peat plant, with sales rights in Penobscot County. Penobscot County includes the cities of Bangor, Dexter and Old Town. The stockholders of the Peat Engineering Co. have voted to ratify a contract with F. T. Dow, inventor of equipment to dry peat. This operation will be watched with much interest, as there are numerous peat bogs in Penobscot County.

Association of Chemical Plant Equipment Manufacturers Will Organize

The organization committee of the Association of Chemical Plant Equipment Manufacturers will call a meeting to be held in New York during the week of May 8 to perfect a permanent organization of the association.

It is expected that the meeting will be addressed by Secretary Hoover and Dr. Julius Klein of the Department of Commerce on the value of industrial associations. There will also be several other speakers who have had practical experience in running expositions and shows.

Definite dates of the meeting will be announced in a later issue.

Bureau of Chemistry Arranges Dust Explosion Exhibit

The engineers of the Bureau of Chemistry have arranged an exhibit showing the need for preventive measures to avoid dust explosions and fires. The exhibit is arranged in three panels. One panel is devoted to grain milling and other food product industries. The second panel is devoted to threshing machines and the method of avoiding danger from fires when threshing is done in dry weather. The third panel is devoted to cotton gin fires. These fires are of almost explosive violence once they are started. Accompanying the exhibit is a stereomotorgraph showing plants wrecked by explosion and fire. The entire exhibit may be obtained by applying to the Department of Argiculture in Washington. It should be in great demand by persons and organizations interested in fire prevention.

A.C.S. Intersection Meeting to Be Held at Akron

Members of the Cleveland Section of the A.C.S. will be the guests of the Akron Section on May 3. The day will be spent in visiting the industrial plants in Akron and in games of various kinds. A dinner will be held in the evening at which Prof. Edgar F. Smith, president of the American Chemical Society, will be the principal speaker.

Dr. W. C. Geer is chairman of the Akron committee.

Examination for Junior Technologist Announced

Examinations for junior technologist in the Bureau of Standards and elsewhere will be held on May 24, July 5 and Aug. 23. Subjects in which examinations will be held include general chemistry and elementary physics, 20 points; mathematics, including calculus, 25 points; practical questions on optional subjects, including the technology of rubber, leather, paper, textiles, oil, and general, 30 points; education, training and experience, 25 points. Salary at the start will be from $1,200 to $1,500 per year. Application must be made on Form 1312 to the Civil Service Commission.

Personal

D. D. BEROLZHEIMER has been appointed manager of the information bureau of the Chemical Catalog Co., Inc., and of the service department of the *Journal of Industrial and Engineering Chemistry*.

J. PARKE CHANNING, president of the Seneca Copper Co., 11 Broadway, New York, has resigned. First Vice-President Linton of the company will act as president until a successor is chosen.

O. L. CHORMANN spoke before the regular meeting of the Rochester, N. Y., Section of the American Chemical Society, April 3, on "Pasteurization of Milk Under Vacuum."

Colonel J. K. CRAIN is to succeed Major J. H. Burns as head of the Ammunition Division of the Ordnance Department of the Army, a division which includes the important nitrate section. Major Burns is relieved because of the statutory requirement limiting service in Washington to 4 years. He goes to San Francisco to become the corps-area ordnance officer for the Ninth Corps Area. Captain D. P. GAILLARD, who has been in charge of the nitrate section of the Ammunition Division, has been made commanding officer at the Old Hickory powder plant. P. E. HOWARD has succeeded him as chief of the nitrate section.

THOMAS FRENCH is establishing a works in New York for the manufacture of certain colors similar to those made under his patents in Canada.

ALVIN C. GOETZ, for the past 3 years with the byproducts division of the Southern Cotton Oil Co., has resigned to accept the superintendency of one of Darling & Co.'s fatty acid distilling plants at Chicago.

CHARLES E. GOLDING, of Trenton, N. J., manager of the Golding Sons' Co., producer of feldspar, flint, etc., has resigned to become head of the Golding-Keene Co., recently organized to engage in a kindred line, with headquarters at Trenton.

H. W. HARDINGE has returned from a business trip through England, France and Belgium.

Dr. R. B. MOORE, chief chemist of the U. S. Bureau of Mines, expects to sail on May 6 for a 2 months' trip to Europe on professional business. He will visit France, Germany, Austria, Czechoslovakia, Holland and Belgium.

H. C. PARMELEE, editor of CHEMICAL & METALLURGICAL ENGINEERING, was married on April 10 to Miss Eugenia McAusland, of Washington, D. C. They will be at home after May 15, corner of Spring and Lefferts Roads, Yonkers, N. Y.

E. C. REEDER, for the past 5 years chief engineer of the Rosiclare Lead & Fluorspar Mining Co., in charge of exploration, development and construction work at Rosiclare, Ill., resigned on March 1, to enter the employ of the Hillside Fluorspar Mines, of the same place, in a similar capacity.

R. T. STULL, who for several years has been superintendent of the Columbus (Ohio) Experiment Station of the Bureau of Mines, has been appointed assistant chief of the bureau's mineral technology division. In that position he will have technical supervision over the work in non-metallics and in ceramics.

Prof. THE. SVEDBERG, of the University of Upsala, Sweden, will organize and direct the research work in colloid chemistry at the University of Wisconsin during the second semester of 1922-23 and the summer session of 1923, and will also give two lectures each week on the subject and conduct two weekly seminaries. During the summer session of 1923, lasting 6 weeks, the lectures given during the second semester will be repeated for the benefit of educators and research workers who find it impossible to attend the university during the regular session. A seminary will also be conducted through the summer session.

Prof. MAXIMILIAN TOCH delivered a lecture at Cooper Union on April 3, on "Chemistry and the Next War," which was illustrated by two reels of moving pictures showing post-war government experiments on bombing operations.

Dr. CHARLES WADSWORTH, 3D, of Chicago, has joined the staff of CHEMICAL & METALLURGICAL ENGINEERING as Assistant Editor, with headquarters in New York. Until recently he was in the operating department of the Grasselli Chemical Co.

Obituary

WILLIAM F. MCNABB, of Pittsburgh, Pa., secretary and treasurer of the Vanadium Metals Co., Vanadium Building, that city, died on March 27, of self-inflicted injuries in a Mount Clemens, Mich., hotel, where he had gone to regain his health. He was 36 years of age and was prominently connected with local industry, being also treasurer and director of the Flannery Zinc Co. and assistant treasurer of the Pittsburgh Electric Furnace Co.

Market Conditions

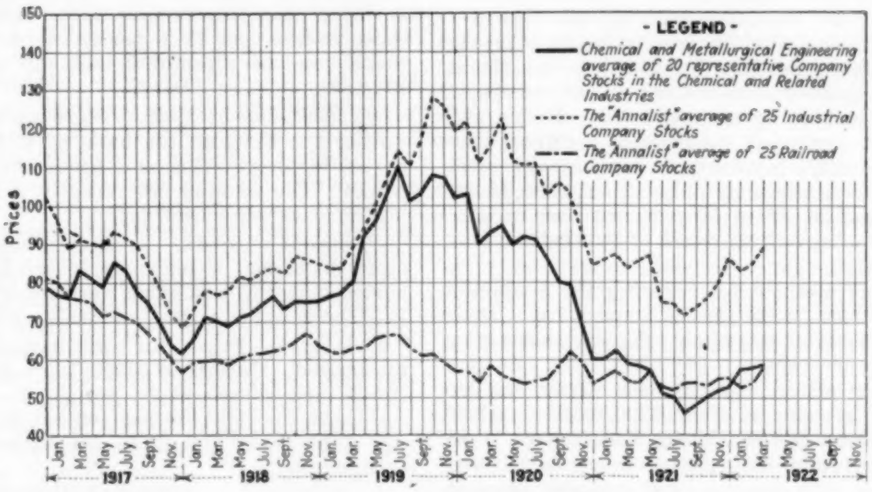
IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

The Chemical Industries and the Stock Market

Coincident with the recent upward trend in wholesale prices there has been a noticeable recovery in the stock market. This return of confidence in business, while perhaps more or less psychological, augurs well for the immediate future of industry.

That the stocks of companies in the chemical and allied industries have followed somewhat the same trend as the general market is evidenced by the accompanying tabulation. For the purposes of this comparison, twenty representative companies operating in the field served by CHEMICAL & METALLURGICAL ENGINEERING were selected and the average price of their stocks was compared with the *Annalist's* averages for twenty-five general industrials and for twenty-five railroad stocks. It will be observed that the curve representing the chemical company stocks has followed with rather striking similarity that of the average for the industrials. The spread between the two curves was practically constant in 1917 and 1918. During the sharp rise that occurred in the first half of 1919 the two curves were almost together. While the chemical stocks, after reaching a peak in July, 1919, continued to show the same general tendencies as the industrials, the recoveries of the former were less effective and the falls more pronounced. The *Annalist* average reached its peak in October, 1919. Neither curve again attained this high level, although in April, 1920, the industrials came within a few points of its former high.



COMPARISON OF PRICES OF CHEMICAL, INDUSTRIAL AND RAILROAD STOCKS

In the decline of 1920 and 1921 it is of interest to note that both curves touched bottom in the same month, August, 1921. The chemical company stocks were practically 15 points beneath their previous low recorded in December, 1917. In the case of the industrials, however, the August, 1921, quotation was still at least a few points above that at the end of 1917. The present upward movement began in August of last year and has proceeded without interruption for the past 7 months. Apparently the average for the twenty-five railroad stocks has also participated in this advance, notwithstanding the fact that since 1918 the curves for industrials and railroads have had but little in common. The outstanding characteristic of the latter stocks during the last 5 years has been their comparative stability as evidenced by the absence of any wide fluctuations.

The companies whose stocks were used for this compilation were selected as representing the principal chemical and chemically controlled industries. The quotations used were the bid prices for common stock adjusted to the basis of a par of 100 and averaged on or about the first of each month. In the case of practically all of these companies their stocks are listed on the New York Stock Exchange. Included in the average are the following: Allied Chemical & Dye Corporation, American Agricultural Chemical Co., American Cotton Oil Co., American Linseed Co., American Smelting & Refining Co., American Sugar Refining Co., Central Leather Co., Corn Products Refining Co., Davison Chemical Co., E. I. du Pont de Nemours & Co., International Nickel Co., International Paper Co., Mathieson Alkali Works, National Lead Co., Texas Co., United Dyewood Corporation, United States Cast Iron Pipe & Foundry Co., United States Rubber Co., U. S. Industrial Alcohol Co., and Virginia-Carolina Chemical Co.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	**158.36**
Last week	156.75
April, 1917	207
April, 1918 (high)	286
April, 1920	261
April, 1921 (low)	140

The gain shown in the index number over last week is due to the rise in price of cottonseed and linseed oil, as well as ammonium sulphate. These higher prices more than offset the slight price reductions in acetic and citric acids, barium chloride, borax, caustic soda and caustic potash.

An Outside View of the Industrial Chemical Market

It is occasionally of interest to get an outside viewpoint on market conditions within the chemical industry. Such a view is afforded in the following statement extracted from a recent industrial letter of the Babson statistical services. While we are inclined to agree with Mr. Babson's views in regard to lowered costs and continued readjustment, we do not believe he is entirely justified in his inference that lower prices can be expected for such staples as alum, bleaching powder and caustic soda.

"The worst of the industrial chemical readjustment is definitely over, yet this does not necessarily mean that the minimum price basis is established. A lower plane is entirely probable. Industrial chemicals represent another group that experienced abnormal expansion to cope with the war demand. Even in the days of urgent demand there was no shortage. Consequently, our total producing capacity today, compared with actual needs, is exorbitant. Since early in 1920 competition has constantly increased.

"The price alignment has marked time more or less with the revision in producing costs, and the cost of production is

destined for lower levels. Incidentally, Europe is in the same category. Her producing ability is large and channels of consumption restricted. Our imports have naturally declined, but our exports have also recorded a drastic setback.

"We cannot disregard the fact that we are still in a period of depression, a condition that will not terminate for some time to come. Industrial activity will improve only gradually, particularly as some of our major industries have yet to complete the transitionary process. The demand for industrial chemicals this year will not be large. The average price is fully above 1913. From a comparative standpoint this is not high, but the unusual conditions that prevail suggest conservatism in such chemicals as alum, bleaching powder, caustic soda and soda ash. A constant supply is the primary incentive."

Better Technology an Imperative Need in the Chilean Nitrate Industry

That Chilean nitrate will continue for a long time to be an important source of fixed nitrogen, in spite of developments which may be made in the technology of nitrogen fixation, is the opinion of Paul F. Holstein of Chicago, an American chemical engineer with 10 years' experience in the nitrate fields, having been assistant manager of one of the American plants. In a recent interview he summarized some of the more important factors affecting the economic outlook for this industry.

Facts which must not be lost sight of are that over $200,000,000 has been invested in this industry and that in the past it has been possible by working the richest caliche to obtain a very substantial return on the investment and still sell under a high government tax. Under such conditions pleas for improved technology received scant attention. More recently, however, it has become necessary to work deposits containing only 17 or even 15 per cent of nitrate instead of 30 to 50 per cent and in addition competition has arisen in the form of synthetic nitrogenous materials.

A thorough study of methods for reducing the production costs of Chilean nitrate is becoming imperative. There are two well-defined lines of approach—the government tax and technology.

Since the beginning of the industry the nitrate tax has enriched the Chilean treasury by about $500,000,000. About two-thirds of the income of the Chilean Government is derived from this source and there is not much in the way of an alternative, so that the tax will probably remain, unless the industry should be seriously threatened. In such an event the government would have to take drastic measures for self-preservation.

Turning to the technology, much room for improvement is seen in the average plant and it has been estimated that a 40 per cent reduction in cost should be possible through improved processes. Better recovery, more efficient fuel utilization, and improved mining methods are problems which, when solved, will do much to decrease the cost of production. In many of the plants at present 30 to 33 per cent of the total cost of the finished nitrate at the plant is charged to fuel, while placing the ore at the plant accounts for 45 per cent more.

Since prices are controlled through a central association, it would seem quite possible for this organization to assist in the technological development rapidly becoming essential to the existence of the industry in the face of competition.

The New York Market

NEW YORK, April 10, 1922.

A slight improvement was reflected in the volume of chemical business during the past week and although conditions in general are far from normal, the tendency is toward betterment. Caustic soda producers report a heavy call for contract shipments and large tonnages have been moved from the works. There was also a decided improvement in the demand for copper sulphate, and heavy orders have been placed for foreign and domestic consumption. Barium chloride is still very scarce and prices have shown a net gain over the week. Sulphide of soda developed a firmer tone, owing to the reduction of imported stocks.

Arsenic.—There were a few sales noted at 7¼c. per lb. during the week and quotations ranged from 7¼@7½c. per lb. Futures were offered at 6¾@7c. per lb., depending upon quantity.

Barium Chloride.—Scarcity at present has created a very strong market and prices are steadily advancing. It was very doubtful if better than $87 per ton could be done at the close of last week. Some sellers were holding for $90 per ton. Domestic producers have been quoting $75 per ton, but practically all these sources are sold up to the latter part of June. Demand is very brisk.

Carbonate of Potash.—The 80-85 per cent material is showing additional strength in the resale market and large manipulators are not willing to quote below 5c. per lb. for prime goods. Quotations range from 4⅞c. per lb. upward.

Caustic Soda.—Resale dealers quote the market at $3.60 per 100 lb. for export, April shipment from works. The market quieted down considerably during the week and foreign inquiries were not very noticeable. Producers, however, report a steady demand for contract shipments and quote the market firm at 2½c. per lb., basis 60 per cent, f.o.b. works, in carload lots.

Copper Sulphate.—There was a decided improvement noted in this commodity, especially from South American countries. The domestic inquiry has also shown improvement and the agricultural demand at present is very active. Considerable business was transacted to Middle Western farmers. Leading factors quote large crystals at 5½c. per lb. in carlots and $5.40 per 100 lb. for the smaller crystals. Some producers report a sold up condition on all large crystals.

Hyposulphite of Soda.—There were a few sales recorded during the week on the basis of $2.90 per 100 lb. for imported material. Domestic producers quote 3c. per lb. f.o.b. works. The demand has recently shown more activity and larger sales were recorded.

Prussiate of Soda.—Keener competition and a quiet inquiry have had a tendency to weaken quotations for imported material and sales were reported down to 16½c. per lb. The movement was practically confined to resale dealers.

Soda Ash.—Prices for spot material remained quotably unchanged. Carlots in single bags are quoted at $1.80 per 100 lb. and barrels at 2c. per lb. Leading producers quote contracts for light 58 per cent at $1.20@$1.25 per 100 lb. for single bags and $1.45 for barrels, basis 48 per cent, f.o.b. works.

COAL-TAR PRODUCTS

There has been a marked improvement in this industry since our last report. Indications all around appear more favorable and the stability of prices throughout the list has restored the confidence of buyers. Resale material is not very plentiful. Producers report a livelier inquiry and it is very significant that passing business is being transacted by first hands. Price changes during the week have been very few. Those close to the pulse of trading believe that the recent recovery to more normal conditions is a very good sign that the bottom has been reached.

Cresol.—First-hand sales of U. S. P. goods are reported at 12@15c. per lb. Ortho-cresol is finding a fair outlet at 16@18c. per lb. The demand is moderate and confined chiefly to small quantities.

Naphthalene.—There has been a much better demand from various sources of seasonable character and resale dealers report additional inquiries. Prices are maintained in first hands. Balls are offered at 8c. per lb., flakes at 6½c. and crushed at 6@6½c. per lb.

Aniline Oil.—Supplies are liberal and the general condition of the market is hardly steady. Buyers have not shown any inclination to operate on a large scale. Producers quote the market at 16½c. per lb.

Benzaldehyde.—Small-lot sales have been the only feature of the market. Sales of the U. S. P. are reported at $1.25 per lb., while the technical is moving at 45c. per lb. The demand is moderate.

Toluidine.—Sales of the mixed have been transacted at 30c. per lb., with smaller lots held up to 35c. The demand is rather quiet, with passing transactions of a small nature.

The Chicago Market

CHICAGO, ILL., April 6, 1922.

The main feature of the industrial chemical market during the past 2 weeks was the firmness of prices. Practically no declines were to be noted and while actual advances were few, spot prices were very firm. Imported material is especially firm, with most stocks at a low point. Dealers and manufacturers are both apparently enjoying a good volume of business and seem to be fairly well satisfied. The trading is mostly in small-sized lots but it is noticeable that a few buyers are beginning to buy ahead.

GENERAL CHEMICALS

Caustic soda is in a firm position and is moving fairly well in small lots. Ground caustic, 76 per cent, is quoted at $4.35@$4.50 per 100 lb. and solid at $3.75@$4. *Caustic potash* is very firm, with spot stocks light. The high test, 88-92 per cent material is quoted at 6¾@7c. per lb. *Potash carbonate* has shown some signs of firmness and 96-98 per cent material is available at 10@12c. per lb. *Soda ash* is reported to be moving well and is unchanged at $2.30 per 100 lb.

Potash alum lacks quotable change at 5@6c. per lb. for the lumps and 6@6½c. for the powdered. *Sal ammoniac* is moving well at 7¾@8¼c. for the white granular. *Copper sulphate* is reported to be moving well and is very firm at 6@6¼c. per lb. *Bleach* is moving fairly well at 3c. per lb. for large drums. *White arsenic* is in good demand and supplies are available at 8c. per lb. There is a good movement of *carbon bisulphide* and prices are firm at 6¾@7c. per lb. *Carbon tetrachloride* is unchanged as to price and is moving fairly well at 10½@11c. per lb. *Formaldehyde* is moving very well, but the price is weak due to competition and the weakness of the methanol market. Agents quote barrels at 9½@10c. per lb. and kegs at 11@12c. *Furfural* is enjoying a fair demand and is quoted in single drum lots at 50c. per lb. *Epsom salts* are moving in a routine way at 2¾@3c. per lb. for the U.S.P. crystals. Glycerine is rather quiet and refiners have announced nothing new in the way of prices. The c.p. material in drums is quoted at 16c. per lb. delivered. *Lead acetate* is quiet, with 12@13c. per lb. quoted on the white crystals.

Nothing new has developed with bichromates. The *potash salt* is quoted at 11¾@13c. per lb. according to the seller and *soda* at 9@9½c. The market is still bare of *potassium ferricyanide*. *Potassium ferrocyanide* is very firm and is moving well at 32@35c. per lb. *Permanganate of potash* is rather neglected and supplies are available at 18c. per lb. *Bicarbonate of soda* is moving in a routine way at 2¼c. per lb. There is a somewhat better demand for *sodium hyposulphite* and the price is unchanged at $3.95 per 100 lb. for the pea crystals in barrels.

LINSEED OIL—NAVAL STORES

Linseed oil continues to move very well in consuming channels. The price is firm and at least a few factors expect higher prices. Today's market was 86c. per gal. for the boiled oil in 5-bbl. lots and 84c. for the raw oil.

Turpentine is reported to be moving briskly and the price is firm. Today's market was 84½c. per gal. for 5-drum lots. *Rosin* is moving somewhat slowly and less than carlots of the WW grade was quoted today at $8.35 per 280 lb.

The Iron and Steel Market

PITTSBURGH, April 7, 1922.

Obviously it is necessary to dig beneath the surface to make an appraisal of the actual condition and prospects in the steel market. The superficial developments are increased demand, increasing production and stiffening prices in some steel commodities, definite advances in others. Superficially there is a great similarity to conditions that have existed in the early stages of all the periods of activity in the steel industry. It must be remembered that the steel trade has always been one of periods of activity interspersed by periods of inactivity. In periods of inactivity there have been starts toward full activity that were not carried to the end, and it has not always been possible to distinguish the one from the other.

At the present time opinion is divided. The facts as to orders are not subject to dispute, the question being as to the rate of consumption. Some argue that when buying of steel has been so heavy with consumption as it has been lately, increased consumption will bring heavier buying in future. Others argue that as consumption does not support the present rate of production the buying will decrease, part of the buying of late having been against replenishment of stock.

PRICES

Bars and shapes recently became quotable at 1.50c. as a general market price, as noted in this report a week ago. Plates seem now also quotable at the advanced figure, making the three heavy rolled products at 1.50c., against about 1.35c. a month ago. There are no rigidly maintained prices, however, in these commodities, concessions being no doubt given in some instances, while on the other hand small and undesirable orders command as high as 1.60c.

Effective yesterday, pipe mills decreased the preferential on plain end pipe from three points to one point, and on pipe with threads and not couplings from two points to a quarter point, beyond the regular discounts for pipe with threads and couplings. Shading of regular published prices has largely disappeared. In some quarters it is thought probable that a small advance in the whole pipe list will soon be made.

Practically all the sheet mills have now completed booking of business at the old prices and the $3 a ton advance announced some time ago by most of the mills as to become effective about April 1 may be regarded as in force. Meanwhile business has been brisk in actual shipping orders as well as in second quarter contracts. The new prices are: Blue annealed sheets, 2.40c.; black, 3c.; galvanized, 4c.; automobile sheets, 4.50c.

Wire products are very firm, plain wire being 2.15c. and wire nails $2.40. Demand for nails is excellent and for wire products in general is very fair.

PRODUCTION INCREASED

The rate of steel ingot production is now between 33,000,000 and 35,000,000 tons a year, having increased rather sharply in the past fortnight. The rate was about 29,000,000 tons at the end of February, and averaged 23,000,000 tons last October and November. Much question is raised as to the disparity between production and consumption, it being urged in some quarters that there is no appearance of such activity in steel consumption as was visible in 1912 and 1913, each of which years saw a production of 30,000,000 tons of ingots. Depletion and replenishment of stocks make a great difference, a fact illustrated by the production of ingots last July at only 11,000,000 tons a year, when obviously consumption must have been at a much greater rate.

The coal strike involves much more idleness at non-union mines than was expected, the lower Connellsville in particular being affected. There will be more drawing upon stocks of coal and coke in April and less non-union production than was expected. The strike at the union mines was generally expected to last 2 months or more, and an interesting question now is whether strikes in non-union districts will last long enough to be a factor at the end.

COKE AND PIG IRON

The Connellsville coke market has stiffened a trifle, spot and prompt furnace coke appearing firm at $3.50, when a week ago the market was quotable at $3.25@$3.50, there being odd lots to be picked up at the lower figure. Many furnacemen express themselves as quite averse to bidding for coke in case of a scarcity, preferring to bank furnaces and thus help their pig iron market, rather than pay extra prices for coke and thus help the coke market.

Pig iron is showing somewhat more activity in most districts and prices are stiffening. The valley market remains quotable at $19.50 for bessemer, $18 for basic and $19 for foundry, but confident predictions are made that the next important sales of basic and foundry iron will be at 50c. advance.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... -	$0.38 - $0.40
Acetone	lb.	$0.10 - $0.10½	.10½- .12
Acid, acetic, 28 per cent	100 lbs.	2.35 - 2.50	2.55 - 3.00
Acetic, 56 per cent	100 lbs.	5.00 - 5.25	5.30 - 5.50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9.00 - 9.50	9.75 - 10.00
Boric, crystals	lb.	.11 - .11½	.11½- .12
Boric, powder	lb.	.11½- .11¾	.11¾- .12½
Citric	lb.	..... -	.45 - .46
Hydrochloric	100 lb.	1.10 - 1.20	1.25 - 1.70
Hydrofluoric, 52 per cent	lb.	.11 - .11½	.11½- .12
Lactic, 44 per cent tech	lb.	.09½- .10	.10½- .12
Lactic, 22 per cent tech	lb.	.04 - .04½	.04½- .05
Molybdic, c.p.	lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric)		..... -	..... - .....
Nitric, 40 deg	lb.	.06 - .06½	.06½- .07
Nitric, 42 deg	lb.	.06½- .06¾	.07 - .07½
Oxalic, crystals	lb.	.11½- .12	.12½- .13
Phosphoric, 50 per cent solution	lb.	.08 - .08½	.08½- .09½
Picric	lb.	.23 - .25	.26 - .32
Pyrogallic, resublimed	lb.	..... -	1.65 - 1.75
Sulphuric, 60 deg., tank cars	ton	11.00 - 12.00	..... - .....
Sulphuric, 60 deg., drums	ton	12.00 - 14.00	..... - .....
Sulphuric, 66 deg., tank cars	ton	17.00 - 17.50	..... - .....
Sulphuric, 66 deg., drums	ton	20.00 - 20.50	21.00 - 22.00
Sulphuric, 66 deg., carboys	ton	..... -	..... - .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 - 20.00	..... - .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 - 22.50	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.	lb.	..... -	.60 - .75
Tannic (tech.)	lb.	.40 - .45	.46 - .50
Tartaric, imported crystals	lb.	..... -	.26½- .28
Tartaric acid, imported, powdered	lb.	..... -	.27½- .30
Tartaric acid, domestic	lb.	..... -	..... - .30
Tungstic, per lb. of WO	lb.	..... -	1.00 - 1.10
Alcohol, ethyl	gal.	..... -	4.75 - 5.50
Alcohol, methyl (see methanol)		..... -	..... - .....
Alcohol, denatured, 188 proof No. 1	gal.	..... -	.32 - .34
Alcohol, denatured, 188 proof No. 5	gal.	..... -	.32 - .34
Alum, ammonia, lump	lb.	.03½- .03¾	.04 - .04½
Alum, potash, lump	lb.	.03½- .04	.04½- .05
Alum, chrome lump	lb.	.07½- .08	.08½- .08¾
Aluminum sulphate, commercial	100 lb.	1.65 - 1.85	1.90 - 2.40
Aluminum sulphate, iron free	lb.	.02½- .02¾	.03 - .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½- .07¾	.08 - .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 - .30½	.31 - .33
Ammonium carbonate, powder	lb.	.07 - .07½	.08 - .09
Ammonium nitrate	lb.	.06½- .07	.07½- .07¾
Amylacetate tech	gal.	..... -	2.00 - 2.40
Arsenic, white, powdered	lb.	.07½- .07¾	.07¾- .08
Arsenic, red, powdered	lb.	.12 - .12½	.12½- .13
Barium chloride	ton	87.00 - 90.00	91.00 - 95.00
Barium dioxide (peroxide)	lb.	.20 - .21	.21½- .22
Barium nitrate	lb.	.06½- .07	.07½- .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾- .04	.04½- .04¾
Blanc fixe, dry	lb.	.04 - .04½	..... - .....
Blanc fixe, pulp	ton	45.00 - 55.00	..... - .....
Bleaching powder	100 lb.	1.60 - 1.75	1.80 - 2.75
Blue vitriol (see copper sulphate)		..... -	..... - .....
Borax	lb.	.05½- .05¾	.06 - .06½
Brimstone (see sulphur, roll)		..... -	..... - .....
Bromine	lb.	.27 - .28	.28½- .35
Calcium acetate	100 lbs.	1.75 - 2.00	..... - .....
Calcium carbide	lb.	.04½- .04¾	.05 - .05½
Calcium chloride, fused, lump	ton	24.00 - 24.50	24.75 - 27.00
Calcium chloride, granulated	lb.	.01¾- .02	.02¼- .02½
Calcium peroxide	lb.	..... -	1.40 - 1.50
Calcium phosphate, tribasic	lb.	..... -	.15 - .16
Camphor	lb.	..... -	.89 - .91
Carbon bisulphide	lb.	.06 - .06½	.06½- .07½
Carbon tetrachloride, drums	lb.	.09½- .10	.10½- .12
Carbonyl chloride, (phosgene)	lb.	..... -	.60 - .75
Caustic potash (see potassium hydroxide)		..... -	..... - .....
Caustic soda (see sodium hydroxide)		..... -	..... - .....
Chalk, precip.—domestic, light	lb.	.04½- .04¾	..... - .....
Chalk, precip.—domestic, heavy	lb.	.03½- .03¾	..... - .....
Chalk, precip.—imported, light	lb.	.04½- .05	..... - .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 - .06½	.06½- .07
Chloroform	lb.	..... -	.37 - .40
Cobalt oxide	lb.	..... -	2.00 - 2.10
Copperas	ton	15.00 - 16.00	16.50 - 30.00
Copper carbonate, green precipitate	lb.	.19 - .20	.20½- .21
Copper cyanide	lb.	..... -	.58 - .60
Copper sulphate, crystals	100 lb.	5.50 - 5.60	5.65 - 6.15
Cream of tartar	lb.	..... -	.23½- .25
Epsom salt (see magnesium sulphate)		..... -	..... - .....
Ethyl acetate com. 85%	gal.	..... -	.60 - .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... -	.93 - 1.00
Formaldehyde, 40 per cent	lb.	.08½- .09	.09½- .10
Fullers earth, f.o.b. mines	net ton	16.00 - 17.00	..... - .....
Fullers earth-imported powdered-net	ton	30.00 - 32.00	..... - .....
Fusel oil, ref	gal.	..... -	2.15 - 2.50
Fusel oil, crude	gal.	..... -	1.25 - 1.50
Glauber's salt (see sodium sulphate)		..... -	..... - .....
Glycerine, c. p. drums extra	lb.	..... -	.15½- .16
Iodine, resublimed	lb.	..... -	4.05 - 4.15
Iron oxide, red	lb.	..... -	.12 - .18
Lead acetate	lb.	..... -	.09½- .12
Lead arsenate, powd	lb.	.14 - .14½	.14½- .15½
Lead nitrate	lb.	..... -	.15 - .20
Litharge	lb.	.07½- .07¾	.08 - .08½
Magnesium carbonate, technical	lb.	.06 - .06½	.06½- .08
Magnesium sulphate, U. S. P.	100 lb.	2.50 - 2.60	2.65 - 2.85
Magnesium sulphate, technical	100 lb.	..... -	1.00 - 1.80
Methanol, 95%	gal.	..... -	.57 - .58
Methanol, 97%	gal.	..... -	.59 - .60
Nickel salt, double	lb.	..... -	.11 - .11½
Nickel salt, single	lb.	..... -	.11 - .11½
Phosgene (see carbonyl chloride)		..... -	..... - .....
Phosphorus, red	lb.	.45 - .46	.47 - .50
Phosphorus, yellow	lb.	..... -	.30 - .35
Potassium bichromate	lb.	.10¼- .10½	.10½- .10¾
Potassium bromide, granular	lb.	..... -	.17 - .23
Potassium carbonate, U. S. P.	lb.	.12 - .12½	.13 - .16
Potassium carbonate, 80-85%	lb.	.05 - .05¼	.05½- .06
Potassium chlorate, crystals	lb.	.06½- .06¾	.07 - .08
Potassium cyanide	lb.	..... -	.42 - .45
Potassium hydroxide (caustic potash)	100 lb.	5.75 - 6.00	6.10 - 7.00
Potassium iodide	lb.	..... -	3.10 - 3.15
Potassium nitrate	lb.	.07¼- .07½	.08 - .09
Potassium permanganate	lb.	.15 - .15½	.16 - .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.26 - .26½	.26½- .27
Rochelle salts (see sodium potas. tartrate)		..... -	..... - .....
Salammoniac, white, granular	lb.	.07 - .07½	.07½- .08
Salammoniac, gray, granular	lb.	.07¼- .07¾	.07¾- .08
Salsoda	100 lb.	1.45 - 1.55	1.60 - 1.85
Salt cake (bulk)	ton	17.00 - 20.00	..... - .....
Soda ash, light	100 lb.	1.80 - 2.00	2.05 - 2.60
Soda ash, dense	100 lb.	1.85 - 1.95	2.00 - 2.50
Sodium acetate	lb.	.04¼- .04½	.04¾- .05
Sodium bicarbonate	100 lb.	1.80 - 1.90	1.95 - 2.40
Sodium bichromate	lb.	.07½- .07¾	.08 - .08¼
Sodium bisulphate (nitre cake)	ton	4.50 - 4.60	4.65 - 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼- .04½	.04¾- .05¼
Sodium chlorate	lb.	.06½- .07	.07¼- .07¾
Sodium chloride	long ton	12.00 - 13.00	..... - .....
Sodium cyanide	lb.	.22½- .26	.26½- .27½
Sodium fluoride	lb.	.09¾- .10	.10¼- .10½
Sodium hydroxide (caustic soda)	100 lb.	3.60 - 3.65	3.70 - 4.20
Sodium hyposulphite	lb.	.03 - .03¼	.03½- .03¾
Sodium nitrite	lb.	.08½- .08¾	.09 - .09½
Sodium peroxide, powdered	lb.	.28 - .30	.31 - .35
Sodium phosphate, dibasic	lb.	.03¾- .04	.04¼- .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... -	.18 - .21
Sodium prussiate, yellow	lb.	.16½- .16¾	.17 - .17½
Sodium silicate, solution (40 deg.)	100 lb.	.85 - 1.00	1.05 - 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.35 - 2.50	2.55 - 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.85 - 1.00	1.10 - 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼- .04½	.04¾- .05½
Sodium sulphite, crystals	lb.	.03½- .03¾	.03¾- .04¼
Strontium nitrate, powdered	lb.	.09½- .10	.10½- .12
Sulphur chloride, yellow	lb.	.04½- .05	.05¼- .06
Sulphur, crude	ton	18.00 - 20.00	..... - .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour	100 lb.	..... -	2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.	..... -	2.00 - 2.75
Talc—imported	ton	30.00 - 40.00	..... - .....
Talc—domestic powdered	ton	18.00 - 25.00	..... - .....
Tin bichloride	lb.	.09 - .09½	.09½- .10
Tin oxide	lb.	..... -	.37 - .38
Zinc carbonate	lb.	.14 - .14½	.14¾- .15½
Zinc chloride, gran	lb.	.05½- .06	.06¼- .06¾
Zinc cyanide	lb.	.42 - .44	.45 - .47
Zinc oxide, XX	lb.	.07½- .08	.08¼- .08½
Zinc sulphate	100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16½— .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% n drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.28 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97-99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.15 — 1.20
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .70
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½— .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — .18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38

Phenol, U. S. P., drums	lb.	.11½—	.15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls.	lb.	.23 —	.24
Salicylic acid, U. S. P	lb.	.25 —	.26
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 —	.12
Sulphanilic acid, crude	lb.	.25 —	.27
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices same as previous report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.10	—	5.15
Rosin E-I	280 lb.	5.20	—	5.25
Rosin K-N	280 lb.	5.85	—	6.60
Rosin W. G.-W. W	280 lb.	7.00	—	7.25
Wood rosin, bbl.	280 lb.	6.25	—	.....
Spirits of turpentine	gal.	.87	—	.87
Wood turpentine, steam dist	gal.	.85	—	.....
Wood turpentine, dest. dist	gal.	.70	—	.70
Pine tar pitch, bbl	200 lb.	......	—	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.....	—	9.50
Retort tar, bbl	500 lb.		—	9.00
Rosin oil, first run	gal.	.36	—	.....
Rosin oil, second run	gal.	.38	—	.....
Rosin oil, third run	gal.	.46	—	.....

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist	gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref	gal.	.52

Fertilizers

Sulphate of Ammonia, f.a.s. .... 100 lb. $3.75

All other prices remain quotably unchanged.

Crude Rubber

Quotations same as report of April 5th.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10	—	$0.10½
Castor oil, AA, in bbls	lb.	.11½	—	.12
China wood oil, in bbls	lb.	.13¼	—	.13½
Coconut oil, Ceylon grade, in bbls	lb.	.08¾	—	.09
Coconut oil, Cochin grade, in bbls	lb.	.09¼	—	.09½
Corn oil, crude, in bbls	lb.	.11	—	.11¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.10	—	.10¼
Cottonseed oil, summer yellow	lb.	.12	—	.12¼
Cottonseed oil, winter yellow	lb.	.13¼	—	.13
Linseed oil, raw, car lots (domestic)	gal.	.79	—	.80
Linseed oil, raw, tank cars (domestic)	gal.	.75	—	.76
Linseed oil, in 5-bbl lots (domestic)	gal.	.82	—	.83
Olive oil, denatured	gal.	1.12	—	1.15½
Palm, Lagos	lb.	.07¾	—	.08
Palm, Niger	lb.	.06	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10	—	.10
Peanut oil, refined, in bbls	lb.	.12½	—	.13
Rapeseed oil, refined in bbls	gal.	.84	—	.85
Rapeseed oil, blown, in bbls	gal.	.86	—	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.10¾	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¾	—	....

FISH

Light pressed menhaden	gal.	$0.54	—	....
Yellow bleached menhaden	gal.	.57	—	....
White bleached menhaden	gal.	.56	—	....
Blown menhaden	gal.	.61	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$900.00		$1,100.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	70.00	—	110.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	15.00	—	17.50
Barytes, ground, white, f.o.b. mills	net ton	17.00	—	23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00	—	21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude f.o.b. mines	net ton	8.00	—	8.00
Casein	lb.	.10½	—	.12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	—	8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	—	9.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaoli n)ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	14.00	—	20.00
China clay (kaolin), imported, powdered	net ton	30.00	—	35.00
Feldspar, No. 1 pottery grade	long ton	6.50	—	6.75
Feldspar, No. 2 pottery grade	long ton	5.75	—	5.90
Feldspar, No. 1 soap grade	long ton	7.00	—	7.50
Feldspar, No. 1 Canadian, for mill	long ton	22.00	—	22.50
Graphite, Ceylon lump, first quality	lb.	.05	—	.07
Graphite, Ceylon chip	lb.	.04	—	.05½
Graphite, high grade amorphous crude	ton	18.00	—	45.00
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	.....
Kieselguhr, f.o.b. N. Y.	per ton	55.00	—	60.00
Magnesite, calcined (crude)	per ton	12.00	—	15.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05½
Pumice stone, domestic, ground	lb.	.06	—	.07
Shellac, orange fine	lb.	86	—	.87
Shellac, orange superfine	lb.	.88	—	.89
Shellac, A. C. garnet	lb.	.68	—	.69
Shellac, T. N.	lb.	.83	—	.84
Silica, glass sand, f.o.b. Indiana	per ton	1.25	—	1.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	—	4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16.00	—	16.00
Silica, building sand, f.o.b. Pa	per ton	2.00	—	2.75
Soapstone	ton	12.00	—	15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	—	12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50	—	12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	—	20.00

Refractories

Magnesite brick, 9 in. straight (f.o.b. works) net ton... $45

All other quotations remain unchanged.

Ferro-Alloys

Spiegeleisen, 18-22% Mn.......... gross ton $30 — $35

Other prices remain same as previous report.

Ores and Semi-finished Products

Quotations remain quotably unchanged.

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.625
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.50
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	29.50
Lead, New York, spot	4.90
Lead, E. St. Louis, spot	4.475–4.50
Zinc, spot, New York	5.30
Zinc, spot, E. St. Louis	4.80

OTHER METALS

Silver (commercial)	oz.	$0.65½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	49.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.48	$2.38
Soft steel bars	2.38	2.28
Soft steel bar shapes	2.38	2.28
Soft steel bands	2.98	2.88
Plates, ¼ to 1 in. thick	2.48	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The Gadsden Clay Products Co. will construct a new power house at its plant and make other extensions and improvements. Gordon Hood is secretary and treasurer.

TROY—The Standard Chemical & Oil Co. is considering plans for the rebuilding of the portion of its plant No. 1, destroyed by fire, March 22, with loss estimated at about $75,000.

MONTGOMERY—The Sloss-Sheffield Steel Co. has tentative plans under consideration for the construction of an addition to its plant, including blast furnace with daily output approximately 250 tons.

RUSSELLVILLE—The Muscle Shoals Rock Asphalt Co., recently organized with a capital of $1,000,000, has acquired property totaling about 3,000 acres of asphalt rock lands and will build a local refining works with daily output of about 1,000 tons. C. E. Dexter, Louisville, Ky., is president.

Florida

ORLANDO—The Yowell-Drew Co. has acquired the local plant of the Orlando Pottery and has plans under way for a number of extensions and improvements. New equipment will be installed. N. P. Yowell is president.

Indiana

EVANSVILLE—The Atomized Products Corp., 6th St., has plans under way for the construction of a 2-story and basement addition, to cost about $75,000, including equipment. B. V. Cain is general manager.

ANDERSON—The International Rubber Co. of America, organized under Delaware laws with capital of $20,000,000, has acquired the local plant of the Quality Tire & Rubber Co. for a consideration of about $200,000 at a receiver's sale. The new owner will use the plant as an initial unit and will make necessary improvements. The company is said to be negotiating for the acquisition of the other plant of the Quality company, located at Elyria, O. J. D. Wiggins is president and general manager; M. D. Ganger is vice-president and superintendent.

EVANSVILLE—The Southern Indiana Gas & Electric Co. will build a large gas retort in connection with an addition to its local gas plant. Frank J. Haas is general manager.

Iowa

DAVENPORT—Fire, March 30, destroyed a portion of the plant of the Mammoth Glucose Co., with loss estimated at about $300,000, including machinery. The southwest wing of the structure was demolished.

DUBUQUE—The Globe Portland Cement Co., 416 McKnight Bldg., Minneapolis, Minn., will soon break ground for the construction of its proposed new local cement mill, comprising a number of buildings, estimated to cost about $1,500,000, including equipment. General building contracts for the work have been let. The C. L. Pillsbury Co., 1200 2nd Ave. South, Minneapolis, is engineer.

Louisiana

ALEXANDRIA—The Alexandria Oil & Refining Co. will soon commence the erection of an addition to its local oil refinery and will install equipment to double approximately the present output. H. T. Clark is president.

MONROE—C. H. Cole and associates are organizing a new company with capital of $250,000, to acquire and operate the local plant of the Monroe Cotton Oil Co. Negotiations for the purchase of the mill are being concluded and possession will be taken at an early date. The new owners plan for the installation of new machinery and will make a number of other improvements in the plant.

ST. ROSE—The Empire Oil & Gas Co., operating the former refinery of the Corson Petroleum Co., has preliminary plans under consideration for the construction of a large addition, to cost approximately $1,000,000, including equipment.

Maryland

CUMBERLAND—The Potomac Glass Co., manufacturer of tableware and glass novelties, is planning for the early occupancy of its new plant addition now nearing completion, and which has been designed to double the capacity. The extension will include a 10-pot furnace and auxiliary equipment, and represents an investment of about $100,000. It will give employment to more than 250 men. George L. Wellington is president.

BALTIMORE—The Rennous-Kleinle Division of the Pittsburgh Plate Glass Co., 3221 Frederick Ave., has revised plans under way for the construction of a 4-story and basement addition, 75 x 205 ft., estimated to cost about $50,000. Bids will soon be asked.

SALISBURY—The Standard Oil Co., Pratt and Commercial Sts., Baltimore, has acquired property on the east branch of the Wicomico River, Salisbury, as a site for a new distributing plant. Construction will soon be commenced on a number of steel tanks, pumping plant and other departments. The company has also acquired property at Cedar Ave. and 33rd St., Baltimore, 100 x 100 ft., and will use the site in connection with its local distributing plant.

Massachusetts

MARLBORO—The Dennison Mfg. Co., Framingham, Mass., manufacturer of paper products, has awarded a contract to the Aberthaw Construction Co., 27 School St., Boston, for the erection of a 4-story plant, 80 x 270 ft., on Maple St., Marlboro, estimated to cost about $500,000, with machinery. It will give employment to more than 500 operatives. Monks & Johnson, 99 Chauncey St., Boston, are architects.

Nevada

RENO—The Candelaria Mines Co. is completing plans for the construction of a new reduction plant on local site, with cyanide unit to have an initial capacity of 200 tons per day, and crushing department 400 tons daily.

New Jersey

TRENTON — The Keystone Pottery Co., New York Ave., has filed plans for the erection of a 1-story addition to its plant. The company specializes in the production of sanitary ware.

GLEN RIDGE—The Matchless Metal Polish Co. has acquired the plant of the Rare Metal Products Co., Bloomfield Ave. near Hillside Ave., which it has been occupying under lease. The plant consists of a main 3-story mill, with power plant, and will be used exclusively by the new owner. The site approximates 2½ acres of land, allowing for later proposed expansion.

New York

LOCKPORT—The A. W. Jack Corp., North Transit Road and Mill St., manufacturer of asbestos mill board and kindred products, will call for bids at once for the erection of a new plant on site adjoining its present works, to consist of a series of five buildings, brick and reinforced concrete, estimated to cost about $350,000, including machinery. Ground will be broken early in May and it is expected to have the plant ready for service by the close of the year. George F. Hardy, 309 Broadway, New York, N. Y., is engineer.

LITTLE FALLS—The Barnet Leather Co., 81 Fulton St., New York, N. Y., is completing plans and will soon take bids for the erection of an addition to its tanning plant at Little Falls, devoted for the most part to the manufacture of calf leathers. It will cost about $100,000, including equipment. Thompson & Binger, 280 Madison Ave., New York, are architects.

BROOKLYN—The Brooklyn Union Gas Co., 176 Remsen St., has completed plans for the erection of a 1-story gas-purifying house at its plant at Smith and 5th Sts.

LONG ISLAND CITY—Fire March 29 destroyed a portion of the 2-story plant of the Imperial Paint Co., 84 10th St., with loss estimated at about $50,000.

LOCKPORT—The Board of Works is planning for the installation of a new filtration plant at the waterworks, with storage reservoir, estimated to cost $360,000. A proposition to authorize James P. Wells, Cutler Bldg., Rochester, N. Y., engineer, to prepare plans is before the Board of Aldermen.

Ohio

FRANKLIN—Fire March 20 destroyed a portion of the local plant of the Vulcanite Roofing Co., manufacturer of paper composition roofing, with loss estimated at $250,000, including buildings and equipment. The company forms the Roofing Division of the Beaverboard Companies, Inc., Buffalo, N. Y., with headquarters at 2246 West 49th St., Chicago, Ill. Tentative plans for rebuilding the plant are being considered.

Pennsylvania

PITTSBURG—The Pennsylvania Chemical & Research Co., care of Loomis & Satterwaite, 410 Lloyd Bldg., architects, has awarded a contract to the Truscon Steel Co., Oliver Bldg., for the erection of a 1-story laboratory at Hays, Pa., 30 x 100 ft.

SHAMOKIN—J. E. Shipman & Son, manufacturers of fertilizer products, have commenced the erection of a new plant to replace their works recently burned.

CLEARFIELD—The Elk Tanning Co. is considering plans for the rebuilding of the portion of its plant destroyed by fire, March 28, with loss estimated at about $300,000, including equipment.

PHILADELPHIA—The E-Z Chemical Co. has leased the 3-story building at 640-42 Rodman St. for a local plant.

WESTFIELD—The Pennsylvania Potash & Fertilizer Co. plans for the erection of a new plant on local site.

Tennessee

CONCORD—H. J. Winfrey & Sons are planning for the construction of two new kilns at their lime works, and will take bids until about May 1.

JACKSONVILLE — The Nashville Pulp & Paper Corp. will commence the erection at an early date of a number of new plant units at its works, Old Hickory Station. Other portions of the plant are now in course of construction. The entire works will consist of about eight complete operating units, estimated to cost close to $1,000,000. R. G. Cullen is engineer.

Texas

FREEPORT—The Freeport Sulphur Co. has leased the sulphur properties of the Texas Co., Houston, Tex., at Hoskins Mound, near Brazaria, Tex., and plans for the immediate development of the land. A complete surface plant will be installed and other production facilities established, estimated to cost in excess of $500,000. It is proposed to be ready for operation in about 10 months.

Virginia

HARRISONBURG—H. W. Dickey, operating the Harrisonburg Sanitary Pottery, is planning for the rebuilding of the portion of the plant, recently destroyed by fire, with loss of about $25,000.

Washington

SPOKANE—The Frantz Oil Corp., Frank Frantz, president, recently acquired by the Mutual Oil Co. of Wyoming and now operated as a subsidiary organization, has plans under way for the erection of a new oil refinery at Spokane, to have a capacity of about 1,000 bbl. per day and estimated to cost approximately 300,000, with equipment. Work will be commenced late in April.

WELLSBURG—The Eagle Glass & Mfg. Co. has awarded a contract to the Truscon Steel Co., Oliver Bldg., Pittsburgh, Pa., for the erection of three 1-story buildings at its plant, with main structure 50 x 100 ft. H. W. Paull is president.

KANAWHA CITY—Fire March 27 destroyed a portion of the local plant of the Libbey-Owens Sheet Glass Co., with loss estimated at about $200,000, including equipment. It is planned to rebuild. Headquarters of the company are in the Nicholas Bldg., Toledo, Ohio.

New Companies

THE FARRELL RUBBER MFG. Co., East Rutherford, N. J., has been incorporated with a capital of $100,000, to manufacture rubber products. The incorporators are John L., A. E., and Thomas A. Farrell, 42 Paterson Ave., East Rutherford.

THE GENERAL PAINT & VARNISH Co., Detroit, Mich., has been incorporated with a capital of $25,000 to manufacture paints, varnish, shellac, etc. The incorporators are Ward H. Peck, Herbert H. Burgess and George E. Cowles, 4344 West Euclid Ave., Detroit.

THE LEBANON BRASS MFG. Co., Lebanon, Pa., has been incorporated with a capital of $10,800, to manufacture brass and bronze products. Frank H. Wise, Lebanon, is treasurer.

THE FARM CHEMICAL Co., Penn Yan, N. Y., has been incorporated with a capital of $5,000, to manufacture agricultural chemicals and other chemical products. The incorporators are K. Van Blarcom, M. J. Rapalee and S. E. Short. The company is represented by C. S. Shepard, Penn Yan.

THE IMPROVED OIL & REFINING Co., Okmulgee, Okla., has been incorporated with a capital of $100,000, to manufacture refined petroleum products. The incorporators are Paul M. Pope and W. B. Bahn, Oklahoma City, Okla.; and R. L. McClure, Okmulgee.

THE SCIENTIFIC CHEMICAL Co., Wilmington, Del., has been incorporated under state laws with a capital of $100,000, to manufacture chemicals and chemical byproducts. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE UNIVERSAL CHEMICAL Co., 16 Beach St., Boston, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by Harry Schlosberg.

THE TOMASEK TERRAZZO MOSAIC Co., 3147 West Van Buren St., Chicago, Ill., has been organized under state laws to manufacture mosaics and other fine ceramics. The incorporators are James E. Tomasek, Edward O. Degrenier and Alexander Campbell.

THE WOODLEY PETROLEUM Co., New York, N. Y., has been incorporated under Delaware laws with capital of $25,000,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE SHAMROCK COTTON OIL Co., Shamrock, Tex., has been incorporated with a capital of $30,000, to manufacture oil products. The incorporators are F. A. Bailey and N. L. Carter, both of Shamrock.

THE CUBAN DOMINICAN SUGAR Co., 101 East Fayette St., Baltimore, Md., has been incorporated with a capital of 1,100,000 shares of stock, no par value, to operate a sugar refinery. The incorporators are Joseph W. Murphy, Frank J. Horan and James B. Guaragha.

THE UNITED LEATHER CORP., New York, N. Y., has been incorporated with a capital of $2,000,000, under Delaware laws, to manufacture leather products. The incorporators are Harold E. Edwards, M. C. Fargis and E. M. Pickert. The company is represented by the Corporation Trust Co. of Delaware, Dover, Del.

THE MITCHELL OIL Co. OF NEW JERSEY, Newark, N. J., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are Theodore G. Hindenlang, Howard W. and George H. Lambert, 9 Clinton St., Newark.

THE FAIRMONT MOLDING CORP., Norfolk, Va., has been incorporated with a capital of $50,000, to manufacture metal castings. W. M. Hannan, Jr., is president, and R. B. Howton, secretary, bothh of Norfolk, Va.

THE MOTH K-L Co., Cranford, N. J., has been incorporated under Delaware laws with a capital of $1,250,000, to manufacture insecticides and other chemical products. The incorporators are P. B. Littlehall, Cranford; M. G. Reese, East Orange, N. J., and H. E. Hilty, New York, N. Y. The company is represented by the Registrar & Transfer Co., 900 Market St., Wilmington, Del.

THE AMERICAN SHALE BRICK Co., Martinsburg, W. Va., has been incorporated with a capital of $100,000, to manufacture brick and other burned clay products. The incorporators are Charles L. Magee, Washington, D. C.; James N. Dyson and F. Vernon Aler, Martinsburg. The last noted represents the company.

THE REX CHEMICAL Co., Salem, Va., has been incorporated with a capital of $1,000,000, to manufacture chemicals and chemical byproducts. The incorporators are Victor Yonce and R. B. Shelor, both of Salem.

THE IVANHOE COPPER Co., Wilmington, Del., has been incorporated under state laws with capital of $600,000, to manufacture refined copper and kindred metals. The company is represented by the corporation Service Co., Wilmington, Del.

THE DAULER OIL Co., Pittsburgh, Pa., is being organized by George B. Berger, Frank S. Delp and W. F. Hughes, to manufacture refined oil products. The company is represented by Calvert, Thompson & Wilson, 1737 Oliver Bldg., Pittsburgh.

THE INDUSTRIAL AROMATIC Co., Newark, N. J., has filed notice of organization to manufacture oil products. The company is headed by J. deSala Mendes, 201 Sherman Ave., Newark.

THE MISSOURI CLAY MINING Co., Poplar Bluffs, Mo., has been incorporated with a capital of $100,000, to operate clay properties, and manufacture burned clay products. The company is headed by John Denton, Ozark, Mo.

THE WILLIAM A. BANKS CHEMICAL Co., Pittsburgh, Pa., is being organized by Robert Carson, E. M. Haller and Carl E. Glock, Pittsburgh, to manufacture chemicals and chemical byproducts. The company is represented by J. M. Graham, 1712 Oliver Bldg., Pittsburgh. Application for a state charter will be made on April 18.

THE TOMLINSON PAINT & VARNISH Co., 2213 North Crawford Ave., Chicago, Ill., has been chartered under state laws, to manufacture paints, varnishes, oils, etc. The incorporators are Edwin W. and Charles N. Tomlinson, and William Sporleder.

THE TIGER OIL Co., Tulsa, Okla., has been incorporated under Delaware laws, with a capital of $1,000,000, to manufacture petroleum products. The incorporators are H. R. McGill, Burton Hartley and Herbert Miller, all of Tulsa. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE NEW NORMA CHEMICAL Co., Memphis, Tenn., has been chartered under state laws to manufacture chemicals and chemical byproducts. The incorporators are D. E. Chamberlin, Gerald A. Cotter and W. H. Englehard, all of Memphis.

THE P. J. BOUR CORP., Pittsburgh, Pa., is being organized by P. J. Bour, George H. Lepper and George H. Sherman, to manufacture heat-and slag-resisting cements and other refractory products. Application for a state charter will be made on April 17. The company is represented by Saul Schein, 1506-10 Berger Bldg., Pittsburgh.

THE POLLYANNA OIL Co., Minneapolis, Minn., has been incorporated under Delaware laws, with a capital of $400,000, to manufacture petroleum products. The incorporators are E. C. Carmen, R. G. Powell and Gordon Cain, Minneapolis. The company is represented by the Corporation Registry Co., 900 Market St., Wilmington, Del.

THE GREAT EASTERN OIL Co., 1119 Fidelity Bldg., Baltimore, Md., has been incorporated with a capital of 600 shares of stock, no par value, to manufacture oil products. The incorporators are George S. Price, George C. Hepp and Marion W. Thomas.

THE VIC RUBBER Co., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture rubber products. The incorporators are S. and M. Gromet, and S. Kaplan. The company is represented by H. H. Feigin, 261 Broadway.

THE EVANSTON GLASS Co., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture glass specialties. The incorporators are Ralph R. Swarthout, William J. Ross and Ralph D. Matteson, 30 North Dearborn St., Chicago.

THE MICHIGAMUA OIL Co., Ann Arbor, Mich., has been incorporated with a capital of $25,000, to manufacture refined petroleum and other oil products. The incorporators are A. M. and John J. Cox, and R. F. Weslie, all of Ann Arbor.

JOHANESON, WALES & SPARKE, INC., New York, has been incorporated with a capital of $100,000, to manufacture pulp and paper products. The incorporators are W. M. Wilson, A. M. Hanson and G. S. Webster, Jr. The company is represented by G. M. Spencer, 120 Broadway, New York.

THE COSMOPOLITAN OIL Co., Indianapolis, Ind., has been incorporated with a capital of $500,000, under Delaware laws, to manufacture petroleum products. The incorporators are Everett C. Arnold, Asher Buck and Frank A. Moore, all of Indianapolis. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE MOORE BRASS WORKS, Wilmington, Del., has been incorporated under state laws, with capital of $50,000, to manufacture brass, bronze and kindred products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ARLINGTON ANILINE WORKS, INC., Peabody, Mass., has been incorporated with a capital of $20,000, to manufacture colors, dyes and affiliated products. Arthur A. Krivian is president; and Bernard Lander, Roxbury, Mass., treasurer.

THE U-MIX-IT CHEMICAL Co., 11 Winthrop St., Hartford, Conn., has filed notice of organization to manufacture chemicals and chemical compounds. M. H. Miller heads the company.

Industrial Notes

THE ORTON & STEINBRENNER Co., of Chicago, Ill., and Huntington, Ind., manufacturer of locomotive cranes, clam-shell and orange-peel buckets and coal crushers, has made arrangements with J. Ross Bates, formerly connected with the Wonham Bates & Goode Trading Corp. of N. Y. and Boston, to represent it in the New England States and New York City. Mr. Bates has offices at 136 Liberty St., New York City, and 128 School St., Watertown, Mass.

THE UEHLING INSTRUMENT Co., manufacturer of CO_2 recorders and other fuel economy equipment, will be located at its factory, 473 Getty Ave., Paterson, N. J., instead of at its former address, 71 Broadway, New York City.

SANDVIK STEEL, INC., announces the consolidation of its general steel and steel belt conveyor departments in Suite 2001, Woolworth Bldg., New York City, with the following executive officers: W. D. Thomas, president and general manager; Anders Johnson, vice-president; Gurrick M. Spencer, secretary, and Harry Carlson, sales manager.

THE WHITLOCK COIL PIPE Co., Hartford, Conn., announces that in addition to its regular agents and representatives it has recently obtained the services of George D. B. Van Tassel, superheater expert, of Detroit, Mich., who will represent the company's interests in Detroit and vicinity.

THE CARBORUNDUM Co., Niagara Falls, N. Y., announces the appointment of Harry Fowler as district sales manager of the Cincinnati territory, to succeed Charles R. Cox. Mr. Cox has been transferred to the main office at Niagara Falls to take up new duties on sales statistics.

THE McCLAVE-BROOKS Co. has appointed the Mahler Machinery & Supply Co., 1445 Syndicate Trust Bldg., St. Louis, Mo., as its sales representative for that district for McClave combustion systems, including stokers, grates, steam blowers, boiler fronts, etc.

THE CELITE PRODUCTS Co., Chicago, Ill., announces that during the last 3 months there have been a number of changes in its sales organization, including the establishment of branch offices in Boston, Buffalo, Cincinnati and Minneapolis. F. W. Emerson is in charge of the Boston office, W. D. VanArnam in the Buffalo territory, L. M. Lindsey in the Cincinnati office and E. R. LaBelle at Minneapolis. A change has been made in the New Orleans office, and J. C. Etheredge is now district manager for that territory.

THE OLIVER CONTINUOUS FILTER Co., 33 West 42nd St., New York, will demonstrate at its New York laboratory the application of the Oliver continuous filter to pulp washing during the convention in New York of the pulp and paper industry the week of April 10. All pulp and paper men will be welcome at this demonstration.

THE COMBUSTION ENGINEERING CORP., New York, announces the opening of a new branch office at 1137 Guardian Bldg., Cleveland, O., which will be in charge of Frank Henderson, who has been associated with several of the prominent stoker companies in that territory.

THE ELECTRIC FURNACE Co. has moved its general and sales offices from Alliance, O., to Salem, O. By this action all departments of the company will be consolidated at its works, Wilson St. and Pennsylvania Railroad, Salem, O.

THE CHAIN BELT Co., Milwaukee, Wis., has announced the appointment of G. F. Sherratt as manager of the Pittsburgh office in the Union Arcade Bldg. Mr. Sherratt will be in charge of all the company's chain and engineering business in the Pittsburgh territory and is equipped to render

engineering service on power transmitting and material handling problems. The Chain Belt Co. specializes on chain and material handling equipment for all industries. The products of the company are manufactured under the trade name of "Rex." The Ward Equipment Co. of Pittsburgh will continue to handle the complete line of Rex concrete mixers and pavers, and the United Equipment Co. the Rex traveling water screens.

W. E. MEGRAW, safety director of the H. H. Robertson Co.'s plant at Ambridge, Pa., was handed a fac-simile of the Rice Safety Award bronze tablet, because of the total elimination of accidents in 1921, at the recent fourth annual banquet of the Western Pennsylvania division of the National Safety Council. Mr. Megraw in a brief talk accepted the award on behalf of the 124 employees who had achieved a record heretofore believed impossible in accident prevention work. This is particularly interesting because in addition to the usual industrial hazards, the men are constantly unloading and handling steel sheets, coating them with asphaltic compounds heated to from 300 to 400 deg., often under severe fume conditions, moving the sheets and the finished product from place to place, and at times working on lines through which hot oils are piped.

THE WESTINGHOUSE ELECTRIC & MFG. CO. announces that owing to increasing activity in the power and railway divisions of the Pittsburgh office the two divisions will be separated. Burton Steveson, who has been manager of both divisions, will continue as manager of the power division and F. G. Hickling has been appointed manager of the railway division.

THE BUTTERWORTH-JUDSON CORP., manufacturer of acids, intermediates and dyestuffs, has canceled its contract with L. M. Bowes, under which Mr. Bowes, doing business as the Standard Color Co., was sole seller of Butterworth-Judson dye products. It is the intention of the Butterworth Judson Corp. to market all of its products through its own selling force. After April 8 the sales offices of the corporation will be located at 30 Church St., New York City. The expansion of the sales department necessitated this changing to larger quarters.

THE WESTON ELECTRICAL INSTRUMENT Co., of Newark, N. J., announces the appointment of the following sales representatives: Shiefer Electric Co., Inc., with offices at Rochester, Buffalo and Syracuse, N. Y., for upper New York State and Erie, Pa.; L. D. Joralemon, Otis Bldg., Philadelphia, Pa., for Pennsylvania, Delaware, Maryland and the District of Columbia, and the Warren C. Graham Co., Carondelet Bldg., New Orleans, La., for Louisiana, Mississippi and lower Alabama.

Capital Increases, Etc.

THE MADISON GLUE MFG. CO., 97 Beekman St., New York, N. Y., has filed notice of increase in capital from $10,000 to $100,000.

THE MAMER BRICK CO., Benton Harbor, Mich., has filed notice of increase in capital from $60,000 to $160,000, at the same time changing its name to the Mamer Co.

THE MANATI SUGAR CO., 112 Wall St., New York, N. Y., is disposing of a bond issue of $8,000,000, the proceeds to be used for general financing, refinery operations, extensions, etc. Regino Truffin is president.

THE STANDARD CLAY CO., a Delaware corporation, has filed notice of organization to operate at Brazil, Ind., with capital of $300,000, to manufacture brick, pipe and other burned clay products. The company is represented by Albert F. Price, Brazil.

THE COLUMBIAN BRONZE CORP., Freeport, L. I., has filed notice of increase in capital from $450,000 to $1,250,000.

THE BINGHAMTON GLASS CO., Binghamton, N. Y., has filed notice of increase in capital from $60,000 to $150,000.

THE UNION BAG & PAPER CORP., Woolworth Bldg., New York, N. Y., with plants at Hudson Falls, N. Y., and other points, is arranging for a bond issue of $15,000,000, of which about $7,000,000 will be offered for sale at an early date.

THE NOCO OIL PRODUCTS CO., St. Louis, Mo., has been organized to take over and consolidate Cleage & Co., St. Louis, Mo., and the Noco Petroleum Co., Kansas City, Mo., and operate oil refineries. Thomas D. Cleage heads the new organization.

THE UNION OIL ASSOCIATION, Los Angeles, Cal., has filed notice of incorporation with capital of $30,000,000, to take over the properties of the Union Oil Co. of Cal., including refineries, pipe lines, etc.

Industrial Developments

RUBBER—The Thermoid Rubber Co., Trenton, N. J., has adopted a capacity day-time operating schedule at its plant. It is planned to inaugurate a night shift at an early date.

The Goodyear Tire & Rubber Co., Akron, O., has increased production from 20,000 to 22,000 tires a day at its local plant, as compared with an output of about 13,000 tires daily during last November. A large increased working force is being employed.

The Goodyear Rubber Co., Middletown, Conn., has increased operations from 4 to 5 days a week at its local plant, giving employment to more than 250 persons.

The General Tire & Rubber Co., Akron, O., is increasing production at its plant, with tire department running at close to regular capacity. The first quarter of the present year has produced a 65 per cent increase in sales as compared with the corresponding period of a year ago.

CERAMIC—Potteries in the East Liverpool, O., district are increasing operations, with bulk production of the 30 plants devoted to general ware and kindred products averaging in excess of 86 per cent of normal at the present time.

The St. Joe Brick Works, Slidell, La., operated by M. P. and C. W. Schneider, have adopted a full-time production schedule on a basis of 40,000 bricks per day, giving employment to more than 100 men.

OIL—The Sapulpa Refining Co., Sapulpa, Okla., has arranged for the immediate resumption of production at its local refinery, following a shut-down for a number of weeks. The plant has a rated output of 5,500 bbl. per day.

PAPER—The S. Y. Beach Paper Co., Seymour, Conn., has resumed operation at its local mill, with employment of about 80 men, following a shut-down for more than a year. The company will make a number of improvements in the plant, with the installation of additional equipment for increased output.

IRON AND STEEL—The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., has placed operations on a capacity basis in the open-hearth department at its Ensley, Ala., works. During the past month the company has blown in three blast furnaces, all devoted to basic iron. Record production is being developed in the line of ingots and billets.

Two of the largest works of the Carnegie Steel Co., at Homestead and Duquesne, Pa., are now operating in all departments, following the blowing in of blast furnaces and resumption at the 72-in. and 110-in. mills. The works have been idle, in part, for some months past. The company will soon blow in the furnace No. 1, at its New Castle, Pa., plant, the only unit now idle at the mill; this will place the works on a 100 per cent basis for the first time in more than a year. Operations have been resumed at the mills at the Mingo Junction, O., plant of the company, with addition of about 100 men to the working force. This plant will soon go on a 100 per cent basis, with the employment of approximately 200 more men. Another blast furnace has been blown in at the Edgar Thomson works of the company at Braddock, Pa., making 7 out of 11 units in service at the mill.

The Brier Hill Steel Co., Youngstown, O., is arranging to blow in another stack during the present month.

The Republic Steel Co., Youngstown, O., is operating at four of the six finishing mills at the plant, and plans to increase production at an early date.

The steel plate mills in the Pittsburgh, Pa., district are now operating in excess of 80 per cent of capacity. Based on prewar figures, this would be greater than 100 per cent of normal plant output.

The Sloss-Sheffield Steel Co., Birmingham, Ala., is planning for an early increase in production at its North Birmingham plant, giving employment to a number of additional men. Steady production is being maintained at the byproduct coke-oven plant of the company in the North Birmingham district.

The Midvale Steel Co. is planning for the immediate blowing in of one of the blast furnaces at its Coatesville, Pa., plant. The stack has been idle since last November.

TIN PLATE—The American Sheet & Tin Plate Co. has resumed operations at the four remaining mills at its Guernsey works, near Cambridge, O., developing full production for the first time since last November. At the Elwood, Ind., plant, the company has started two more double mills in operation, bringing the works to 90 per cent of capacity.

COKE—The H. C. Frick Coke Co. is arranging for the early resumption of operations at its Whitney plant in the Scottsdale, Pa., district, following an idle period of 13 months. A total of 250 ovens will be lighted for initial service. The company has added 750 ovens to the active list at the Uniontown, Pa., works.

Coming Meetings and Events

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

AMERICAN WELDING SOCIETY will hold its annual meeting April 26-29 at the Engineering Societies Building, New York City.

CANADIAN INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY will hold their annual meetings in Ottawa May 15-17.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the third Monday of April, instead of the second Monday as usual.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY and the AMERICAN PULP AND PAPER ASSOCIATION are holding annual meetings at the Waldorf-Astoria, New York, this week.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.